GROUNDWATER MIGRATION CONTROL SYSTEM FINAL REMEDIAL ACTION COMPLETION REPORT

Prepared for
Solutia, Inc.
575 Maryville Centre Drive
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October 9, 2009

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SOLUTIA
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October 12th, 2009

Ms. Leah Evison
U. S. EPA - Region 5
77 West Jackson Boulevard (SR-6J)
Chicago, Illinois 60604-3590

RE: GMCS Final Remedial Action Completion Report

Overnight Mail

Dear Leah:

Attached, please find our Final Remedial Action Completion Report. Our hope is that this document incorporates the minor changes that were requested and is ready for approval.

Any questions, please advise.

Sincerely

Steven D. Smith

cc: Sandra Bron – IEPA - 2 hard copies
Lisa Cundiff – CH2M Hill – 2 hard copies
Richard Williams – 1 hard copy
Steve Smith – 2 hard copies

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GLOSSARY OF ACRONYMS AND ABBREVIATIONS

ABRTF	American Bottoms Regional Wastewater Treatment Facility
ACMS	Automated Control and Monitoring System
AOC	Administrative Order of Consent
ASTM	American Society for Testing and Materials
bgs	below ground surface
BMPs	Best Management Practices
cm/sec	centimeters per second
DHU	Deep Hydrogeologic Unit
ENTACT	ENTACT & Associates
ESD	Explanation of Significant Difference
GMCS	Groundwater Migration Control System
Golder	Golder Associates
gpm	gallons per minute
INQUIP	INQUIP Associates, Inc.
MHU	Middle Hydrogeologic Unit
NGVD	National Geodetic Vertical Datum
NPDES	National Pollutant Discharge Elimination System
O&M	Operations and Maintenance
OU-1	Sauget Area 2 Site Wide Operable Unit
OU-2	Sauget Area 2 Groundwater Operable Unit
PCBs	Polychlorinated Biphenyls
ppb	parts per billion
ppm	parts per million
PSC	Philip Services Corporation
RA	Remedial Action
RD/RA	Remedial Design/Remedial Action
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SA2	Sauget Area 2
SHU	Shallow Hydrogeologic Unit
SOW	Statement of Work
SVOC	Semivolatile Organic Compound
SWPPP	Stormwater Pollution Prevention Plan
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
URS	URS Corporation
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound

On October 3, 2002, the United States Environmental Protection Agency (USEPA) issued an Administrative Order for the remedial design and interim remedial action (the Order) associated with the Sauget Area 2 Groundwater Operable Unit (OU-2). The Order was sent to a list of potentially responsible parties (PRPs) for the Sauget Area 2 Superfund site. The Order (Docket No. V-W-’02-C-716) directed respondents to perform a remedial design for the interim groundwater remedy described in the associated Statement of Work (SOW) and the Record of Decision (ROD) dated September 30, 2002, and to implement the design by performing an interim remedial action. A final design was submitted to USEPA as required by the Order.

The final design submittal was developed in accordance with the previously submitted Remedial Design/Remedial Action Work Plan (RD/RA Work Plan) as required by the Order, and was consistent with the design criteria and assumptions established in the Order as well as within the Statement of Work and the Record of Decision associated with the Order. The selected remedy to accomplish the objectives as stated in the RD/RA Work Plan was a Groundwater Migration Control System (GMCS). Key elements of the GMCS include:

- Institutional controls
- Groundwater recovery wells
- Treatment and discharge of extracted groundwater
- Groundwater quality monitoring, groundwater level monitoring, and sediment and surface water monitoring
- Installation of an approximately 3,300-ft long U-shaped barrier wall between the down gradient boundary of Sauget Area 2 Site R and the Mississippi River.

Detailed descriptions of the elements of the selected remedy (i.e., extraction wells, monitoring program, barrier wall, etc.) can be found in Section 2 of the RD/RA Work plan. This Remedial Action (RA) Completion Report pertaining to OU-2 is intended to summarize the design and construction of the Barrier Wall portion of the GMCS located at Sauget Area 2, Site R as well as discuss installation of the Groundwater Extraction Wells, Monitoring Wells and Piezometers, as well as the construction of the Groundwater Discharge System which are also components of the GMCS. This RA completion report discusses OU-2 which addresses the release of contaminated groundwater into the Mississippi River from the Sauget Area 2 site in the vicinity and upgradient of Site R.

1.1 SITE DESCRIPTION

Site R is a closed industrial-waste disposal area owned by Solutia Inc., and is located between the flood control levee and the Mississippi River in Sauget, Illinois (USEPA, September 2002). Site R is bordered by Riverside Avenue on the north and Site Q on the east and south. The location of Site R can be viewed in Figure 1-1. The landfill has been known over time as the "Sauget Toxic Dump," "Monsanto Landfill," and the "River's Edge Landfill" (USEPA, November 2000). The former landfill occupies approximately 24 acres of the 36-acre site.

Access to Site R is restricted by a perimeter fence surrounding the site and is monitored by Solutia plant personnel. Additionally, warning signs are posted on the fence surrounding the site.

1.2 ENVIRONMENTAL SETTING

Site R is located within the 100 year floodplain of the Mississippi River in an area known as the American Bottoms. Topographically, the area consists primarily of flat bottomland although local topographic irregularities do occur. Generally, land surface in the American Bottoms slopes from north to south and from east to west toward the Mississippi River. Land surface elevation of the American Bottoms ranges from 400 to 410 feet above Mean Sea Level (MSL). During the last glaciation (Wisconsin Episode), the American Bottoms was filled with outwash to about 480 feet above sea level based on tributary terrace elevations. Following the retreat of sediment-rich continental glaciers from the Midwest, the Mississippi River evolved from a braided to a meandering system. The meandering Mississippi River migrated across the central and western portions of the valley to its present location, depositing sand, silt, and clay unconformably on top of the outwash (Grimley and Lepley, 2005).

1.3 DISPOSAL HISTORY

Site R was used as a disposal area by then owner Pharmacia for its industrial and chemical wastes from approximately 1957 until 1977. Hazardous and non-hazardous bulk liquid and solid chemical wastes and drummed chemical wastes from primarily two local Pharmacia plants were disposed at Site R (USEPA, September 2002). Disposal began in the northern portion of the site and expanded southward. Wastes were known to contain phenols, aromatic nitro compounds, aromatic amines, aromatic nitro amines, chlorinated aromatic hydrocarbons, aromatic and aliphatic carboxylic acids and condensation products of these compounds (USEPA, September 2002). In 1979, Pharmacia completed the installation of a clay cover on Site R to cover waste, limit infiltration through the landfill, and prevent direct contact with fill material. The cover's thickness ranges from 2 feet to approximately 8 feet.

According to Notification of Hazardous Waste Site forms submitted to USEPA by Pharmacia, waste types including organics, inorganics, solvents, pesticides, heavy metals, and general chemical wastes were disposed at Site R (Pharmacia, May 1981a; Pharmacia, May 1981b). The listed volume of waste included 178,000 cubic feet from the Pharmacia Queeny Plant and 7,800,000 cubic feet from the W.G. Krummrich Plant. Forms were also submitted by other entities without listed volumes.

1.4 IDENTIFIED HISTORICAL CONTAMINATION

Samples taken from Site R revealed high levels of organics, PCBs, metals, and dioxins. The organics present in Site R include chlorobenzenes, chlorophenols and aniline derivatives.

The following information was presented in the AOC (USEPA, November 2000).

Soil and Sediment

This site has been sampled extensively by USEPA, IEPA, and Pharmacia starting in the early 1980s. A summary of the data collected at Site R are presented here. According to the USEPA, sediment samples collected from a drainage ditch surrounding Site R showed VOC concentrations ranging from 0.002 to 0.035 ppm. SVOC concentrations in sediments ranged from 0.045 to 3.99 ppm. PCBs were detected at concentrations ranging from 0.08 to 1.5 ppm. Elevated levels of metals, particularly aluminum, iron and magnesium were also detected. Sediment samples collected adjacent to the Mississippi River on the west side of Site R showed SVOC contamination ranging from 0.001 to 7.7 ppm. PCBs were also detected at concentrations ranging from 0.00001 to 0.23 ppm. Soil samples collected from Site R showed elevated levels of VOCs ranging from 0.15 to 5,800 ppm. SVOCs were found at levels ranging from 0.017 to 19,000 ppm. Pesticides were found at levels ranging from 0.011 to 99 ppm, and PCBs were detected at levels ranging from 0.075 to 4,800 ppm. Elevated levels of arsenic, chromium, lead, nickel and mercury were also detected in Site R soils.

Leachate

According to the USEPA, leachate samples associated with Site R have also been collected adjacent to the Mississippi River. SVOC concentrations in the leachate ranged from 0.6 to 12.3 ppb. Pesticide concentrations ranged from 0.5 to 3.0 ppb and PCBs were detected at 0.08 ppb. Dioxin/furan concentrations ranged from 0.0001 to 0.0014 ppm. Cyanide was also detected at 71 ppb.

Surface Water

Surface water samples have been collected from the adjacent waters of the Mississippi River near Site R. According to the USEPA, dioxins were found in the water ranging in concentration from 0.0001 to 0.0007 ppm.

Groundwater

Extensive groundwater investigations have also been conducted at Site R. According to the USEPA, samples collected from wells on and immediately downgradient of Site R have shown high levels of VOCs in concentrations up to 38,136 ppb. SVOC concentrations have also been detected as high as 2,973,885 ppb.

1.5 REMOVAL ACTIONS

No removal actions at Site R have been documented in available historical records.

2.1 GMCS REQUIREMENTS SPECIFIED IN THE ROD

Based on the risks associated with the release of impacted groundwater to surface water downgradient of Sauget Sites O, Q (dog leg), and R; Sauget Area 1 Site I; the W.G. Krummrich plant, Clayton Chemical Facility and other industrial facilities in the Sauget area (See Figure 2-1), the following Remedial Action Objectives were identified in the ROD for the Interim Groundwater Remedial Action:

- Protection of aquatic life in surface water and sediments from exposure to site contaminants,
- Prevent or abate actual or potential exposure to nearby human populations (including workers), animals or the food chain from hazardous substances, pollutants or contaminants,
- Prevent or abate actual or potential contamination of drinking water supplies and ecosystems,
- Achieve acceptable chemical-specific contaminant levels, or range of levels, for all applicable exposure routes,
- Mitigate or abate the release of contaminated groundwater in the plume area to the Mississippi River so that the impact is "insignificant" or "acceptable" as required by the May 3, 2000 W.G. Krummrich RCRA AOC (EPA Docket No. R8H-5-00-03).

In order to address the release of contaminated groundwater to the Mississippi River, a GMCS consisting of the following components was constructed and is currently being operated and maintained.

Physical Barrier – A 3,273-foot long, "U"-shaped, fully penetrating, barrier wall was installed between the downgradient boundary of Sauget Area 2 Site R and the Mississippi River to abate the release of impacted groundwater (Figure 2-2). The barrier wall extends along the approximately 2,000 feet north/south length of Site R with the arms of the "U" extending approximately 650 feet to the east (upgradient), past the eastern boundary of Site R and terminating before the USACE floodwall. Three partially penetrating groundwater recovery wells were installed inside the "U"-shaped barrier wall to control groundwater moving to the wall.

Groundwater Treatment – Extracted groundwater is treated the American Bottoms Regional Wastewater Treatment Facility (ABRTF) to meet all relevant and appropriate discharge requirements.

Groundwater Quality Monitoring – Groundwater quality samples are collected downgradient of the engineered barrier to determine mass loading to the Mississippi River resulting from any contaminants migrating through, past or beneath them.

Groundwater Level Monitoring – Groundwater level monitoring is performed to ensure acceptable performance of the physical barrier. Groundwater elevation data from water-level measurement piezometers is used for gradient control behind the barrier wall and to regulate pumping rates of the three extraction wells to abate the release of impacted groundwater to the Mississippi River.

Sediment and Surface Water Monitoring – Sediment and surface water samples are collected in the plume release area to determine the effect of any contaminants migrating through, past or beneath the barrier wall and being released to the Mississippi River.

Institutional Controls – Institutional controls are being utilized to limit fishing in the plume release area by limiting site access, posting warning signs, and implementing a public education program.

2.2 POTENTIAL FUTURE LAND USE

At the current time, Solutia intends to own the property indefinitely. It is commercial property and is intended to stay as such.

2.3 REMEDIAL DESIGN

As constructed, the Barrier Wall is a 3,273-foot long, fully penetrating wall constructed between the down-gradient boundary of Site R and the Mississippi River (Figure 2-2). The Barrier Wall extends vertically from approximately three feet bgs to the bedrock surface, nominally 132 to 143 feet bgs, and is designed to reduce recharge from the Mississippi River into the middle hydrogeologic unit (MHU) and deep hydrogeologic unit (SHU). The Barrier Wall is 3.0 feet wide. An extraction well system consisting of one 10-inch and two 12-inch extraction wells ranging in depth from 110 to 140 feet bgs is located on the east side of the Barrier Wall (upgradient) and serves as the primary control mechanism for the GMCS.

The extraction wells were designed to capture the groundwater discharging into the barrier wall. Locations of the extraction wells can be viewed in Figure 2-3. The extraction wells are typically constructed as shown in Figure 2-4 and have Type 304 stainless steel screens with 0.040-inch wide slots from about 40 feet below the existing ground surface to 5 feet above the bottoms of the wells. The bottom 5 feet of each well consists of Type 304 stainless steel tight-wind screen (zero slot). Installation data for the extraction wells are given in Tables 2-1 and 2-2. Extraction well installation logs are included in Appendix A of this document and are also included in the Golder Associates report on the installation of extraction wells and piezometers. The alignment of the effluent pipeline is shown in Figure 2-5.

The Barrier Wall reduces the volume of groundwater flow into the GMCS from the Mississippi River during operation of the groundwater extraction pumps. The Barrier Wall alignment was selected to place the Barrier Wall as close to the river as feasible, as well as to minimize underground obstructions. (See Figure 3-1 for details on underground obstructions.)

The average design permeability of the in-place wall is less than 1 x 10^{-7} cm/sec based on laboratory testing. This design parameter was chosen as performance criteria, but was not critical to the design. If the permeability of the wall was greater than indicated above, the system would not be compromised. Because the extraction wells are the primary control mechanisms for this system, additional recharge from the river through the wall would simply result in additional quantities of groundwater to be extracted, but would not influence the objective of the overall control system which is to control groundwater discharge to the Mississippi River from the area east of the extraction wells.

The barrier wall was constructed using the slurry method. The ability to construct a continuous barrier with limiting discontinuities depended on a number of factors, including:

- The soil type(s)
- The type of excavation equipment
- The type and configuration of mixing equipment
- The backfill mix
- The backfilling procedures.

With the exception of the soil type(s), all of these parameters were dependent on the type of equipment selected to construct the wall by the contractor. Upon selection, the contractor provided a wall designed by an engineer registered in the State of Illinois. Mueser Rutledge Engineers designed the barrier wall on behalf of the selected contractor, INQUIP Associates, Inc.

Because of the variability in techniques and equipment, the wall and mix parameters could not be specified until a contractor had been selected. Once INQUIP was selected as the contractor, they were required to develop and implement a pre-construction test program designed to determine the critical parameters to be used during construction at this site, including mix design and properties. Materials for the barrier wall included bentonite, water, imported borrow clay, and the in-situ soils along the wall alignment. Non-toxic and biodegradable admixtures such as fluidifiers and retarders could have been used by design, but they were not needed. The actual backfill mix was determined by multiple laboratory compatibility tests and bench scale tests performed by the Owner's Engineer and the Contractor.

2.4 ROD AMENDMENTS AND MODIFICATIONS

The OU-2 ROD specified that the barrier wall was to be constructed using jet grouting technologies. However, due to financial considerations and construction limitations of the jet grouting method, an alternate means of barrier well construction was sought out, eventually approved and implemented. The method chosen involved the construction of a bentonite/soil slurry wall installed using the slurry trench method of excavation. Approval of this change in construction techniques was documented in an Explanation of Significant Difference (ESD) issued in 2003.

In response to the Record of Decision, a pump and treat system was installed at Site R. Groundwater extraction wells and piping to the off-site treatment facility were constructed. In addition, the Barrier Wall and piezometers were also installed.

3.1 GROUNDWATER MIGRATION CONTROL SYSTEM

A summary of the extraction well installation data is as follows:

Extraction Well Installation Data[1]

Well	Elevation (Ft, NGVD)					Length (Ft)			Well OD (in.)
	Ground Surface	Center-line of Disch. Pipe	Top of Screen (Exposed)	Btm of Screen	Btm of Well	Casing (bgs)	Exposed Screen	Blank	
EW-1	422.02	417.29	369.0	291.0	285.8	53.0	78.0	5.2	12.75
EW-2	418.53	415.26	380.3	313.6	308.5	41.5	63.4	5.1	10.75
EW-3	420.58	416.26	364.1	294.6	289.3	56.7	69.4	5.3	12.75

Detailed descriptions and dimensions of the pumps and their characteristic curves (based on factory tests on the actual original pumps installed in the wells using different motors) as well as installation logs of the extraction wells and piezometers are included in Appendix B. Current pump installation data is as follows:

[1] Well installation data are from Well Completion Records prepared by Dave Meyer, Layne-Western Division, Layne Christensen Company, July 28, 2003

Pump Installation Data

Well	Top of Riser Elevation (ft, NGVD)	Elevation (ft, NGVD)		Drop Pipe Dia. (in.)	Grundfos Model No.	Flow (gpm)	Efficiency (%)	Shutoff Head (ft)	Motor HP
		Discharge (centerline)	Pump Intake						
EW-1	422.72	417.29	340	6	625S400-2-1	700	80	235	40
EW-2	419.84	415.26	337	5	475S400-3	680	73	310	30
EW-3	421.45	416.26	339	6	625S400-2-1	700	80	235	40

Limitorque electric valve actuators were added to the plug valves in February 2005. The actuators communicate the position of the valve (% open) to the MCU using a 4-20 milliamp signal. Electronic float switches were added in each concrete vault. The float switches are set to automatically stop the pumps if flooding of the vault is detected.

The Automated Control and Monitoring System (ACMS) is a primary component of the Groundwater Migration Control System. The ACMS has been designed based on the following parameters:

- Automatically monitor flow from three extraction wells. Each well has a maximum pumping capacity of about 700 gpm. Therefore, the total system capacity is about 2100 gpm.
- Automatically read and record Mississippi River stage elevations.
- Automatically adjust pump flow rates based on operating criteria discussed below in Section 1.3 “Description of Prescribed Operation Conditions”.
- Remote alarm annunciation in the event of system operational problems.
- Maintain measurement database for monthly archiving purposes.
- ACMS components have been selected and located to minimize the potential effects of a 100-year flood event (approximately Elevation 425 feet, NGVD at Site R) on the system.

Numerous components make up the ACMS and are detailed in the Operations and Maintenance Report. See Appendix B.

Eight pairs of piezometers have been installed as part of the GMCS. Locations of the extraction wells and piezometers can be viewed in Figure 2-3. Details of these installations are also included in Appendix B.

Installation of the discharge pipeline was conducted by Philip Services (PSC) of Columbia, Illinois during June of 2003. The purpose of the pipeline was to transfer water from the GMCS Extraction Wells to the American Bottoms Regional Waste Water Treatment Facility (ABRWTF). The entire pipeline was installed below grade.

The 12 inch diameter HDPE pipe was installed from Extraction Well #3 (Station 0+00) to Station 29+60. The 2,960 feet of pipe was placed in an excavated trench and backfilled.

From Station 29+60 to Station 31+48, the pipeline increased in diameter from 12 inches to 20 inches. This 188 feet section of the discharge line ran beneath Pitzman Avenue, the USACOE flood control levee and existing railroad tracks. This section of the discharge line was placed in an existing 30 inch diameter concrete pipe.

At Station 31+48, the 20 inch diameter pipe reduced back down to 12 inches in diameter and was installed inside of an existing 30 inch concrete pipe to the termination point at Station 43+30. These 1,152 feet of discharge pipeline did not require excavation or backfill. The terminal point of the discharge pipeline is into the village of Sauget concrete Manholes located at the northeast corner of the P-Chem. property. The discharge pipe is fitted with valves to direct the flow into either of the concrete vaults. An automatic water sample collection device is installed at the discharge vaults to collect water samples prior to treatment.

The discharge pipeline location is shown on Figures 2-5A and 2-5B.

3.2 BARRIER WALL DESIGN

The primary control mechanism for the Groundwater Migration Control System (GMCS) is the three extraction wells. The Barrier Wall reduces the volume of groundwater flow into the GMCS from the Mississippi River during operation of the groundwater extraction pumps. The Barrier Wall alignment was selected to place the Barrier Wall as close to the river as feasible, as well as to minimize underground obstructions. (See Figure 3-1 for details on underground obstructions.)

3.2.1 Subsurface Conditions

Additional conditions that affected the design and construction of the Barrier Wall were the subsurface conditions of the site. This site is located in the American Bottoms physiographic province. Bedrock is approximately 130 to 140 feet below ground surface.

Three hydrogeologic units can be identified: 1) a shallow hydrogeologic unit (SHU); 2) a middle hydrogeologic unit (MHU); and 3) a deep hydrogeologic unit (DHU). The SHU is 30 to 40-ft thick and includes the Cahokia Alluvium (recent deposits) and the uppermost portion of the Henry Formation. This unit is primarily an unconsolidated, fine-grained, stratum with low to moderate permeability. The MHU is 40-ft thick and formed by the upper to middle, medium to coarse sand of the Henry Formation. At the bottom of the aquifer is the DHU, which includes the high permeability, coarse-grained deposits of the lower Henry Formation. This zone is estimated to be about 30- to 40-feet thick.

Recharge of the aquifer occurs through four sources: 1) precipitation; 2) infiltration from the Mississippi River; 3) inflow from the buried valley channel of the Mississippi River; and 4) subsurface flow from the bluffs that border the floodplain on the east. During normal and low river stage conditions, groundwater at Sauget Area 2 flows from east to west and discharges to the Mississippi River, the natural discharge point for groundwater in the American Bottoms aquifer. When flood stage occurs in the Mississippi River, flow reverses.

From October to December 2002, ten additional borings were drilled along the planned barrier wall alignment. The primary objective of the exploration program was to obtain data from a depth of approximately 70 feet to bedrock, specifically focusing on the attributes of a clay interval that had previously been identified in the area (at depths of approximately 115 to 125 feet bgs). The clay unit was limited and did not ultimately factor into the Barrier Wall Design. Boring logs and other geotechnical data are included in Appendix C.

In addition to the drilling program mentioned above, all three permanent pumping wells and eight piezometers (used for groundwater level measurements) were installed prior to construction of the Barrier Wall. Details of these installations are included in Appendix A.

3.2.2 Basis of Barrier Wall Design

As stated above, a fully penetrating, barrier wall was constructed between the down-gradient boundary of Sauget Area 2 Site R and the Mississippi River. The barrier wall was designed to reduce recharge from the Mississippi River in the MHU and DHU. It extends vertically from about 3 ft below grade to the top of bedrock, nominally 132 to 143 ft below grade. The barrier wall was designed and constructed to produce a continuous barrier.

The average design permeability of the in-place wall was less than 1 x 10^{-7} cm/sec based on laboratory testing. This design parameter was chosen as performance criteria, but was not critical to the design. If the permeability of the wall was greater than indicated above, the system would not be compromised. Because the extraction wells are the primary control mechanisms for this system, additional recharge from the river through the wall would simply result in additional quantities of groundwater to be extracted.

Elements of the barrier wall design were completed by the contractor (INQUIP Associates) and the contractor's design engineering firm (Mueser Rutledge Engineers). The barrier wall was constructed using the slurry method. The ability to construct a continuous barrier with limiting discontinuities depended on a number of factors, including:

- The soil type(s)
- The type of excavation equipment
- The type and configuration of mixing equipment
- The backfill mix
- The backfilling procedures.

Drawings used to solicit bids for construction of the barrier wall are included in Appendix D.

Because of the variability in techniques and equipment, the wall and mix parameters could not be specified until a contractor had been selected. Once INQUIP was selected as the contractor, they were required to develop and implement a pre-construction test program designed to determine the critical parameters to be used during construction at this site, including mix design and properties. Materials for the barrier wall included bentonite, water, imported borrow clay, and the in-situ soils along the wall alignment. Non-toxic and biodegradable admixtures such as fluidifiers and retarders could have been used by design, but they were not needed. The actual backfill mix was determined by multiple laboratory compatibility tests and bench scale tests performed by the Owner's Engineer and the Contractor.

3.2.3 Installation Sequence

The actual construction sequence was determined by INQUIP. Key elements of the construction sequence included the following:

- Preparation of trial mixes and selection of an optimum mix that was compatible with site groundwater.
- Mobilization of required equipment to construct the barrier wall.

- Site preparation and work pad preparation.
- Perform exploratory excavation to a depth of 20 feet along alignment.
- Barrier wall installation from the bottom up along the wall alignment.
- Demobilization and site clean up.

A key element of the installation sequence that required modification and impacted the completion of the Barrier Wall was the discovery of unstable subgrade conditions. The contractor, while conducting site preparation, intended to have a 1 foot thick gravel work pad for the excavation equipment to work from. However, it became apparent in some areas that the subgrade was unstable under construction loads. This was observed when the excavator mobilized to the intended starting location of the Barrier Wall excavation at Station 12+50 and encountered 20 feet thick of previously placed fly ash.

The contractor then moved the excavator to the north portion of the site where subgrade conditions were found to be stable. Instead of starting the Barrier Wall excavation at Station 12+50 and excavating northward as anticipated, the contractor had to modify the excavation sequence. The contractor re-mobilized the excavator to approximately Station 27+50 and began excavating southward while subgrade conditions were being investigated at the south end of the site. After test pit and borehole investigations, it was decided to install wick drains throughout the unstable area and allow a perched water table to drain downward through a fly ash layer into the lower sand layers. This decreased the pore pressures in the upper surface layer materials. In addition to the installation of the wick drains, the contractor constructed thicker and wider gravel work pads to better distribute the heavy loads of the barrier wall excavation equipment (1266 Koehring and Liebherr clamshell rigs).

During the installation of the wick drains and construction of the work pad, the contractor continued the Barrier Wall excavation from the north to south to prevent additional delays in the construction schedule.

3.2.4 Barrier Wall Alignment

As stated previously, the barrier wall is a U-shaped wall between the down gradient boundary of Site R and the Mississippi River. Approximately 2,000 ft of this wall runs parallel to the river bank and two arms (approximately 650-ft long) extend on the north and south sides of the Site R.

The Barrier Wall Alignment is presented in Figure 2-2. Along the western edge of the site, the wall was located as close as 25 ft from an existing fence that forms the boundary of the site at the top of the riverbank. This location allowed for construction-related equipment to move between the wall and the fence. It also provided for an area on the east side of the wall for excavation of slurry pits to handle spoils that were generated during wall construction.

The north arm of the wall was located in the pavement of Riverview Avenue. A fence separating the south side of the road from the north edge of the landfill was removed. North of the road, several utilities existed, including a buried water line, buried product lines, several sewer lines, and above ground electrical power and telephone lines. A large drainage ditch also lies just north of the road. Overhead power and telephone lines on the south side of the road were relocated to the north side to allow barrier wall excavation equipment access to work. Electrical power lines crossed the road at several points and were relocated as needed. The south half of the pavement was selected for the location of the wall because: 1) this location limited the number of overhead electrical power and phone lines that had to be relocated; 2) it was away from the buried utilities; 3) avoided the alternative of constructing the wall in the ditch that ran along the north side of the landfill, and 4) presented a shorter distance with fewer obstructions for supply of the barrier wall material from a centrally located batch plant. The wall extended eastward to the existing security gate that defined the eastern extent of the landfill.

The south arm of the wall was initially to be located 10 ft south of the fence that defines the south side of the landfill. This property is owned by others and is used for the movement of large trucks in and around an existing industrial building. See Figure 2-1 for property boundaries. This location was selected to minimize the impact of the wall on the off-site commercial operations. However, due to the close proximity of an electrical tower foundation, the south arm of the wall was realigned further south extending onto the adjacent property and eastward to the end of the fence line that defines the eastern extent of the landfill.

Construction of both the north and south arms of the barrier wall was conducted in areas that did not have room for excavation of slurry pits to contain the spoils. In these areas, the contractor loaded spoils on haul trucks and transported the excavated spoils to the designated stockpile and to temporary stockpile areas adjacent to the barrier wall.

Construction of the barrier wall required a batch plant for mixing of the slurry. The batch plant was set up near the west center of the existing site, west of the landfill. The mixing area was estimated to be approximately 50 by 150 feet. Deliveries of bentonite to the batch plant were made by tractor-trailers.

3.2.5 Temporary Winter Shutdown

On December 17th, 2003 the contractor was instructed to temporarily suspend Barrier Wall excavation when Solutia filed for Chapter 11 bankruptcy protection. At this time the site went into a temporary winter shut down mode. The contractor was required to continue management of storm water and monitor and maintain the slurry level in the open Barrier Wall trench excavation for stability purposes. Due to stability concerns some excavation continued until December 23, 2004. Barrier Wall construction activities resumed on March 31 and excavation with the Koehring 1266 track hoe resumed on April 1, 2004. Trench maintenance and cleaning activities were conducted during the shut down period. The top of the previously placed backfill was cleaned to pre-shut down conditions prior to the resumption of the barrier wall construction.

3.3 SITE PREPARATION

The barrier wall site construction plan was developed after review of historical documents, photographs, existing site plans, and site visits. Several physical constraints were documented during the investigation of the existing site conditions and these, in turn, dictated the design of the barrier wall. These constraints included existing foundation pilings, utilities, buildings, remains of old tank foundations, an abandoned raney well, and other subsurface obstructions. See Figure 3-1. The final location of the wall was selected to avoid as many of the surface and subsurface obstacles as possible and provide adequate room to move equipment, materials, and personnel during construction of the wall.

The location of the barrier wall is outside of the boundaries of the Site R landfill area. Many of these obstacles such as overhead power lines, fences and culverts had to be temporarily or permanently relocated to allow construction.

The contractor, (INQUIP Associates, INC.) was required to perform general site preparation prior to beginning the Barrier Wall construction. These tasks included activities such as grubbing and stripping vegetation and topsoil from the alignment of the Barrier Wall. The contractor also constructed site haul roads and access roads, equipment work pads, storm water containment berms around the impacted construction areas, and a spoils stockpile to contain excavation spoils.

3.4 BENTONITE/SOIL BARRIER WALL - DESCRIPTION AND PROPERTIES

3.4.1 Components of Slurry

The slurry trench method of excavation consists of excavating a trench in the existing soils while at the same time keeping the trench filled with a bentonite-water slurry mixture. The purpose of the slurry is to maintain the stability of the excavated trench.

Slurry is a stable, colloidal, thixotropic suspension of powdered bentonite in water. Bentonite is natural clay whose principal mineral constituent is sodium montmorillonite. Soil-bentonite is a low strength mixture of soil and bentonite-water slurry. The soil used to make the backfill was taken from the excavation spoils and approved clay borrow sources.

Bentonite used in preparing the bentonite-water slurry and soil bentonite backfill mix was sodium montomorillonite, Fed Jel 90 (FJ-90) or approved equivalent. Imported bentonite met the latest version of API Standard 13A "Specification for Oil Well Drilling Fluid Materials." Bentonite material certifications were presented in Appendix E. Water for mixing slurry was obtained form the public supply mains and was sampled and analyzed prior to use to ensure that it did not contain any constituents that would adversely affect the slurry properties. The following were the requirements for the slurry.

	Fresh Slurry	**Trench Slurry**
Filtration	20 cc max filtrate loss or less	20 cc max filtrate loss, with filter cake thickness <1/4 inch
Viscosity (Marsh Funnel)	40-65 seconds	40-100 seconds
Sand Content	Max 2% by volume	Not tested
pH	7 to 9	7 to 10.5
Density	> 63.5 pcf	75 to 85 pcf (min of 78 pcf in flyash area)

3.4.2 Components of Backfill

Barrier wall backfill was a mixture of naturally-deposited, on-site and off-site soils (as required), dry bentonite, and bentonite slurry proportioned to provide an hydraulic conductivity of less than or equal to 1×10^{-7} cm/sec when mixed to a homogenous consistency and placed within the excavated slurry trench in a controlled manner. The on-site soil material was excavated from the slurry trench and off-site soil material (as required) was brought to the site from an approved off-site source. The maximum allowable particle size in the backfill was 3 inches. The gradation requirements of the backfill were as follows:

U.S. Standard Sieve Size	Percent Passing by Dry Weight	
	Min	Max
3 inches	100	
1 inch	85	100
½ inch	75	100
#4	60	100
#10	50	100
#40	35	75
#200	20	40 % typical 50% max

The on-site soils were generally free of roots, rubbish, organics, or other foreign matter which could be detrimental to the backfill mix.

3.4.3 Trench Excavation Procedures

The barrier wall was constructed using slurry wall techniques by a specialty contractor on a design-build basis. The slurry method of excavation consists of excavating a trench in the existing soils while at the same time keeping the trench filled with bentonite-water slurry. The purpose of the slurry was to maintain the stability of the walls of the trench. The slurry was displaced by backfill material as the wall was constructed. The backfill material was less permeable than the native material, resulting in a barrier that impedes groundwater flow.

The contractor was permitted to use a backhoe, excavator, and/or cable operated clam shell buckets which could excavate the full width of the trench. Excavation equipment was capable of removing material of any nature within the limits of the trench required for Barrier Wall construction. The excavation penetrated the subsurface soils to the elevations shown in Figures 3-2A through 3-2D, and were terminated at the top of bedrock. Where encountered, boulders were removed from the trench. Trench continuity was demonstrated by the movement of the trench excavation equipment such that the equipment could be passed vertically from top to bottom of the trench as well as moved horizontally along the axis of the trench without encountering an obstruction. Trench continuity was also demonstrated by monitoring the movement of the placed backfill.

The Contractor excavated the slurry trench in a continuous series of steps. A track hoe was first used to excavate a lead-in slope (approximately 1:1 slope) to an approximate depth of 80ft. The track hoe then continued trench excavation to +/- 80 ft. Clamshell rigs were then used to continue the lead-in slope to bedrock, and then continue excavation of the barrier wall trench from +/- 80ft to bed rock by excavating a series of panels and wedges. The panel and wedge layout is presented in Figures 3-2A through 3-2D.

Slurry was introduced into the trench at the same time trenching began and was maintained in the trench during excavation and until backfilling had been completed. The Contractor maintained stability of the excavated trench at all times for its full depth. The level of the bentonite slurry was generally maintained within 2 feet of the work platform surface to maintain the stability of the trench. The Contractor had personnel, equipment, and materials ready or on call to raise the slurry level at any time, including on weekends or holidays.

Soil excavated from the trench that was suitable for use as backfill was stockpiled adjacent to the working platform or in the temporary spoils stockpile constructed on the landfill for blending with off-site soil borrow material (if required), bentonite, and slurry. Cobbles greater than or equal to 3 inches in diameter were excluded from the soil-bentonite trench backfill and were removed during mixing.

3.4.4 Backfill Preparation

Backfill introduced into the trench had to be a stable, homogeneous mixture of soil excavated from the trench, imported soil from an off-site borrow source (if necessary), slurry, and dry bentonite if necessary. The backfill mix was designed by the contractor and submitted to the Contractor’s Engineer (Mueser Rutledge) for approval. The resulting backfill mix required a hydraulic conductivity less than or equal to 1 x 10^{-7} cm/sec. The trial mix required a hydraulic conductivity of 5 x 10^{-8} or less. Testing for hydraulic conductivity of the backfill material was completed per ASTM D 5084 on backfill samples before installation. Backfill was primarily mixed at locations adjacent to the trench. Mixing of backfill within the trench was not permitted. The Contractor had to demonstrate suitability of the backfill mix before placement.

Backfill material was mixed adjacent to the trench or at a remote mixing area approved by the Owner. After clearing and grubbing, remote backfill mixing areas were prepared by placing a compacted layer of soil suitable for inclusion within the backfill. Backfill mixing surfaces were typically constructed with borrow fill to limit incorporating underlying soil into the backfill.

While mixing and blending backfill at the mix pad; slurry was added to the backfill to control slump. Backfill slump was measured in accordance with ASTMC-143. The backfill slump was continuously checked visually, and physically measured twice a day before the backfill was placed into the trench. Dry bentonite was added to the prepared backfill as determined by the bench scale backfill testing. Other than addition of slurry or dry bentonite to adjust the slump, no soil or gravel was added after samples for laboratory testing were taken. Prepared backfill was required to have a slump ranging from 3 to 6 inches with an average of all slump measurements of 4.5 inches or less.

Frozen backfill was not permitted to be placed in the trench. Backfill mixing and placement was suspended when the temperature of the backfill was below 30 degrees (F) and air temperatures below 28 degrees (F) or when, in the opinion of the Owner, adverse weather conditions did not permit proper mixing.

Prepared backfill was also required to have a laboratory tap water permeability of $1x10^{-7}$ cm/sec or lower, except 20% of the test specimens could have a permeability as high as $5x10^{-7}$ cm/sec and 5% of the test specimens may have a permeability as high as 1.10^{-6} cm/sec.

3.4.5 Backfill Placement

The depth of the trench bottom and the backfill slope were measured, sampled, cleaned if required, and approved by the Owner daily before backfill placement. All activities at the site were overseen by EPA's full time oversight contractor.

Backfill Quality Control tests (except permeability and gradation) were completed daily to confirm that the backfill met specification requirements. A copy of the specifications is included in Appendix F. Samples for permeability and gradation testing were taken from the mixing area prior to placement into the trench.

Initially, the backfill was placed into the trench at one location by a dozer using a lead-in slope until the backfill emerged from the slurry surface and achieved a natural angle of repose, extending to the trench bottom. In order to promote "mud wave" type displacement of slurry and sediment in the trench, backfill was placed at a single location until the backfill slope could no longer advance with additional backfill placement. Free dropping of backfill through slurry was not permitted. Backfill was placed on the surface of previously placed backfill near the point at which the backfill entered the slurry surface. Backfill was placed in such a manner that the backfill displaced the slurry and intermixing of the backfill and slurry did not occur.

Throughout the placement of backfill, the toe of the advancing backfill slope along the barrier wall alignment had to be a minimum of 40 ft and a maximum of 100 ft from the closest point of excavation. This was a specification requirement based on standard industry practice.

The toe of the backfill material at the terminal end was re-excavated daily (as the backfill rose to the top of the trench) to remove entrapped slurry, silt, sediment, and sand that may have existed. Backfill cleaning and measurement data are presented in the Appendix G.

The Owner's engineer representative performed compatibility testing to evaluate backfill performance when permeated with site groundwater, and mix design testing to determine that added dry bentonite or imported clay would be beneficial to the backfill performance. The contractor performed quality control sampling, testing, and measurements.

3.4.6 Barrier Wall Cap

The Contractor constructed the cap over the barrier wall. See Figure 3-3. The Contractor used onsite and or imported fill materials approved by the design engineer and the Owner to construct the cap. A layer of 20 mil plastic sheeting (to preserve the integrity of the barrier wall backfill) and Tensar reinforcement grid was placed to separate the cap material from the in-place barrier wall backfill. Drainage swales were constructed per the Contract Drawings to the original grades.

3.5 SPOILS HANDLING AND STORAGE

3.5.1 Volume and Type Of Spoils

The actual volume of the stockpile on top of Site R was surveyed and calculated to be 21,090 cubic yards. In addition, 17,585 cubic yards of spoils were spread along the inside of the barrier wall, from Station 12+00 to 26+00 to promote drainage. See Figure 3-4. (Correspondence relating to the placement of spoils inside of the barrier wall is included in Appendix H.) The spoils in the stockpile on top of Site R were capped as stated below. The spoils adjacent to the barrier wall were covered with a minimum of 6 inches of topsoil and then seeded to form a vegetative cover.

There were a variety of types of spoils generated during the construction of the barrier wall. Material from the following sources comprises the spoils: 1) excavated soil; 2) bentonite slurry; and 3) excess or spilled backfill mix. Therefore, the spoils were any combination of clay, sand, gravel, boulders, debris, and slurry/grout.

3.5.2 Spoil Stockpile on Top of Site R

Barrier Wall construction generated spoils that were collected and transferred to a spoils stockpile on top of Site R. The methods for spoils handling were determined by INQUIP. Spoils were handled by different methods for different portions of the barrier wall. From approximately Station 10+00 to 31+00, INQUIP placed the material along the trench alignment to dry. Debris, boulders and other unwanted spoils material (e.g., fly ash) would then be removed and hauled to the spoils stockpile on top of Site R. Spoils from the rest of the excavation were hauled directly the spoils stockpile on top of Site R.

Use of the stockpile on top of Site R for spoils storage had to be modified because of a number of factors, including the lack of available storage space for wet spoils along the Barrier Wall alignment and the amount of rainfall, with the consequent volume of contact storm water generated. This lack of storage space along the wall alignment did not allow spoil storage to promote drying prior to placement into the spoils stockpile. Consequently, wet spoils were placed in the stockpile after other storage areas along the trench alignment were filled.

On a couple of occasions the project received heavy rainfall which created large quantities of contact water that exceeded the storage capacity of the modular tanks. During these heavy rainfall events, the contractor elected to pump the remaining contact water to the spoils stockpile area once the modular tanks were filled. This water was then pumped to the modular tanks as holding capacity became available.

Because the material was not placed in a compactable state, the spoils required stabilization. INQUIP began stabilization activities during the fall/winter of 2004. Cement was used as the stabilizing reagent and introduced at a rate of about 10% by weight. In January 2005, Philip Services Corporation (PSC) was contracted to complete the stabilization activities and grade the spoils stockpile on top of Site R to the contours shown on the construction drawings (Figure 3-4). PSC used a 3:1 cement/Code “L” mixture as the stabilizing reagent and introduced it at a rate ranging from 8% to 12% to achieve the desired density. Code "L" is a powdered lime product often referred to as kiln dust.

Barrier Wall construction generated spoils that were collected and transferred to a spoils stockpile on top of Site R. The long term plan is to incorporate this stockpile into the final remedy for Sauget Area 2. The methods for spoils handling were determined by the barrier wall contractor. Spoils were handled by different methods for different portions of the barrier wall. For the section of the barrier wall constructed parallel to the river, the majority of the spoils were contained within a holding area constructed by building a berm between the toe of the landfill and the barrier wall. The area within the berm was low and formed an effective containment area for the spoils and excess slurry.

Spoil disposal along the north and south legs of the “U” was handled differently because those sections of the wall would be built on property not belonging to Solutia or through the pavement of Riverview Avenue. See Figure 2-1 for property boundaries. In those areas, spoil pits were not practical and the contractor had to collect and transport the spoils in site haul trucks as it was generated. The fluid spoils were hauled to temporary drying pits, after which the spoils were removed and trucked to the stockpile where they were placed and compacted. Once placed into the stockpile area, the spoils were graded and compacted using a front end loader or bulldozer.

Drying pits were restricted to areas outside of the existing Site R landfill, but within the Site R property boundaries.

The perimeter of the stockpile was constructed of clean soil material imported from an off site borrow source. The stockpile was designed to contain soil or dry, hardened material from the slurry pits. If the slurry was not dry, temporary drying pits were required prior to placement in the stockpile.

3.5.3 Interim Cover

ENTACT & Associates, LLC was contracted in mid-May 2005 to construct the interim cover. As shown in Figure 3-3, a clean soil layer was placed on top of the excavated spoils to provide a leveling layer between the spoils and an HDPE geomembrane. ENTACT then placed the 60mil HDPE over the entire spoil stockpile on top of Site R, including the 1H:1V slopes. The side slopes were then flattened to 3H:1V by the addition of compacted soil placed on top of the HDPE membrane. Riprap was then placed on the exterior side slopes of the stockpile to protect it from, scour and erosion. Finally, a vegetative layer was placed on top of the HDPE cover. ENTACT completed construction of interim cap in June 2005. A cross-section view of the side slope construction is included in Figure 3-3.

3.6 CONSTRUCTION SCHEDULE

The completion of the Site R Barrier Wall was originally scheduled for the middle of January, 2004. However, completion actually occurred approximately one year behind schedule. Multiple factors contributed to the delay in schedule, including:

- INQUIP’s original daily production estimates were overly optimistic, with the result that the original project schedule was also optimistic.
- Multiple large equipment break-downs and malfunctions were experienced on the project.
- Some sub-grade conditions required additional stabilization to support the heavy excavation equipment.
- Excavation of the subsurface materials was slower than anticipated because of the presence of large boulders and areas of ledge rock. This led to frequent delays because of equipment breakage and down time for repair.
- The supply of bentonite to the site was inconsistent and sporadic at times, primarily because of the unavailability of suitable trucks.

- Solutia filed for Chapter 11 bankruptcy protection, and the site went into a temporary shut down and maintenance mode.
- Inclement weather.

A more detailed chronology follows in Section IV of this report.

3.7 STORMWATER MANAGEMENT

Regulations specified that this site contractor provide a stormwater pollution prevention plan. Due to the nature of the materials being handled on site, special provisions for managing stormwater were required. A Stormwater Pollution Plan (SWPPP) that meets the requirements of the National Pollutant Discharge Elimination System (NPDES) and State of Illinois regulations was prepared prior to starting Barrier Wall construction activities. This process involved implementing best management practices (BMP's) for stormwater runoff that did not contact construction spoils. A copy of the site specific SWPPP is presented in Appendix I.

The contractor controlled and transferred stormwater in accordance with the SWPPP. Stormwater coming in contact with excavated spoils; either in the spoil stockpile or along the Barrier Wall alignment was designated as "contact water" and was collected and pumped to the on site modular storage tanks for reduction of suspended solids and subsequent transfer to the American Bottoms Waste Water Treatment Facility. Transfer of the contact water was through the existing Extraction Wells discharge pipeline.

3.8 SITE RESTORATION

As construction of the Barrier Wall was completed, the contractor restored the site to a clean and neat condition. Portions of the site surface were graded to prevent free standing surface water. The As-built Drawings are presented in Figures 3-2A through 3-2D.

The contractor stockpiled spoils on site as designated by the Owner, removing all temporary dams, road crossings, and other temporary structures, removing all rubbish and construction debris, hauling debris off site to a disposal area approved by the Owner, and filling all temporary excavations and slurry pits not otherwise filled with material from adjacent pits or with topsoil. The contractor re-graded the site to the original pre-construction drainage patterns, or to a grading plan approved by the Owner, grading the site surface to prevent standing surface water, and then applying seed and fertilizer at rates specified by the supplier. The site restoration was inspected and approved by EPA.

It should be noted that the groundwater and surface water restoration is not the aim of the interim RA for OU2. The RI/FS for OU-1 will address what additional remedial actions will be appropriate for the Area 2 sites.

A summary of the chronology of events and construction schedule follows.

Date	Event
September 30, 2002	• Issuance of the ROD for OU2.
October 3, 2002	• Administrative Order for Remedial Design and Interim Remedial Action (the Order) associated with the Sauget Area 2 groundwater operable unit (the OU) was sent by the USEPA to a list of potentially responsible parties (PRPs).
December 19, 2002	• Submittal of RD/RA Work Plan to USEPA and subsequent approval.
February 4, 2003	• EPA conditional approval of RD/RA Workplan.
May 13, 2003	• EPA approval of groundwater extraction and disposal portion of Pre-Final Design.
November 2002 to August 2003	• Pre-Remedial Action groundwater sampling and design preparation activities.
July 30, 2003	• EPA issues ESD re slurry wall construction change.
August 18, 2003	• Mobilization for RA construction, as documented in EPA's 5 year review.
Week of September 8, 2003	• INQUIP began excavation of the Barrier Wall at approximately station 27+50.
Week of September 20, 2003	• Ranney Well #3 was located and grouted shut. The Ranney Well was suspected to be a potential route of slurry loss during the Barrier Wall excavation.
Week of October 11, 2003	• Contractor began placement of Barrier Wall backfill materials.
Week of November 22, 2003	• Contractor began operating day and night shifts.
Week of November 29, 2003	• Strata Services w/Layne Drilling mobilized equipment on-site to begin grouting the 54 inch box culvert at the northwest corner of the site in the location where the Barrier Wall intersects the box culvert.
Week of December 13, 2003	• Barrier Wall construction activities were shut down by

Date	Event
	Solutia until further notice on Wednesday, December 17, 2003.
Week of December 27, 2003	• Limited Barrier Wall construction activities continued. Activities included maintenance of trench stability, backfill placement, and minimal excavation between stations 11+50 and 13+50.
Week of January 31, 2004	• The site was placed into a winter shut down mode. Contractor was requested to control stormwater and maintain the slurry level within the trench.
Week of March 6, 2004	• Preparation work begins to restart Barrier Wall construction activities.
March 31, 2004	• Barrier Wall Construction Resumes
Week of April 22, 2004	• Contractor began using a de-sanding unit to remove sand from the in-place trench slurry.
Week of June 19, 2004	• Contractor completed excavation of the south leg of the Barrier Wall to station 5+00.
Week of July 10, 2004	• Contractor resumed second shift of Barrier Wall construction activities.
Week of July 31, 2004	• Placement of the Barrier Wall backfill (south leg) was completed to station 5+00. • Contractor began placement of backfill in the north portion of the Barrier Wall from station 24+50 north.
Week of August 14, 2004	• Contractor began installation of settlement plates on 200 foot intervals.
Week of September 18, 2004	• Contractor was informed that the backfill tracking profile indicates a blockage in the trench preventing the toe of the backfill from advancing. The blockage was determined to be a partial wedge that had not been fully excavated.
Week of September 25, 2004	• The trench blockage or partial wedge was removed allowing the toe of backfill to advance. • Construction of the Barrier Wall Cap began. • Rough site grading began.
Week of October 2, 2004	• Contractor completed excavation of the Barrier Wall trench (October 4, 2004) to bedrock at station 37+93 (end of Barrier

Date	Event
	Wall).
Week of October 9, 2004	• Toe of backfill reach end of the Barrier Wall excavation.
Week of October 16, 2004	• Contractor began slurry solidification test cells using cement and on-site spoils
Week of November 6, 2004	• Barrier Wall construction was completed to station 37+93 on November 8, 204.
Week of November 13, 2004	• Contractor began placement of 6 inches of topsoil over graded areas. • Contractor began demobilizing construction equipment.
Week of December 11, 2004	• Contractor complete Barrier Wall Cap construction from station 31+30 to 37+93 (end of the Barrier Wall).
Week of December 18, 2004	• Contractor completed placement of topsoil along the northern portion of the landfill and adjacent to Riverview Avenue.
Week of January 1, 2005	• Contractor (INQUIP) was informed to demobilize all equipment.
Week of January 8, 2005	• INQUIP began complete demobilization from the Site. • PSC Phillips Environmental mobilized on-site to monitor and maintain existing control dikes, silt fencing, and contain contact stormwater.
Week of January 15, 2005	• Roberts Environmental Drilling, Inc. on-site to redevelop Barrier Wall piezometers PZ-1N, PZ-1S, PZ-2E, PZ-2W, -PZ-3E, PZ-3W, PZ-4W and PZ-4E
Week of January 29, 2005	• Final portion of the Barrier Wall Cap was completed from station 25+25 to 26+00. • Rockhill Mechanical was on-site to install new valves at EW-3, EW-2 and EW-1.
Week of March 12, 2005	• URS set up to perform trial Rossum Sand tests on EW-1, EW-2 and EW-3.
Week of March 19 through April 9, 2005	• Performed Rossum Sand test on EW-1, EW-2 and EW-3.

Date	Event
Week of May 7, 2005	• PSC completed the placement and grading of topsoil.
Week of May 14, 2005	• Entact began mobilization of equipment to construct the Temporary Spoils Stockpile Cap. • Layne Drilling and Prosonic began drilling PZ-5D, PZ-5U, PZ-6D, PZ-6U, PZ-7D, PZ-7U, PZ-8D, and PZ-8U.
Week of May 21, 2005	• Entact began construction the Temporary Spoils Stockpile Cap. • Prosonic and Layne Drilling completed PZ-5D, PZ-5U, PZ-6D, PZ-6U, PZ-7D, PZ-7U, PZ-8D, and PZ-8U.
Week of May 28, 2005	• URS installed colored marker signs to locate the under ground utilities. 1. Blue – Effluent Pipeline 2. Red – Power lines to EW-1, EW-2, EW-3 and Data Wires. 3. Yellow – Placed at ±10 foot offsets on both sides of the Barrier Wall to mark the location along the Barrier Wall alignment.
Week of June 4, 2005	• Entact w/ESI completed installation of the HDPE cap on the Temporary Spoils Stockpile.
On-going	• Semi-annual Monitoring Well and Mississippi River surface water and sediment sampling.

5.1 GMCS PERFORMANCE AND GOALS

The overall goal of the GMCS is to control the migration of impacted groundwater from beneath and upgradient of the site into the Mississippi River. To achieve this overall goal, a system of three groundwater extraction wells located hydraulically upgradient of a barrier wall were installed at Sauget Area 2, Site R (Figure 2-3) between November 2002 and June 2005.

The barrier wall consists of a U-shaped barrier that fully penetrates the Shallow Hydrogeologic Unit (SHU), the Medium Hydrogeologic Unit (MHU) and the Deep Hydrogeologic Unit (DHU) between the downgradient boundary of Site R and the Mississippi River. It is designed to abate the discharge of impacted groundwater from beneath Sauget Area 2 Sites O, Q (Dog Leg), R and S; Sauget Area 1 Sites G, H, I and L; the W.G. Krummrich plant and other industries in the Sauget area. It extends along the entire 2,000-feet north/south length of Site R, with the arms of the "U" extending to the eastern, upgradient end of Site R. The barrier wall extends from approximately 3 feet below ground surface to the top of bedrock.

A system of three partially penetrating groundwater extraction wells with a capacity to pump from 0 to approximately 2,100 gallons per minute (gpm) is used to capture groundwater discharging into the "U" shaped barrier wall. Extraction wells with screens, installed across the entire MHU and all but the bottom 10 feet of the DHU, are installed between the barrier wall and the downgradient side of Site R (Figure 2-3).

Stated simply, the amount of groundwater that naturally flows into the barrier wall equals the amount of groundwater that is pumped from the site by extraction wells, thus preventing groundwater from mounding up behind the barrier wall and flowing out around the edges of the wall. Darcy's law is used to calculate the groundwater flow into the barrier wall as estimated by using groundwater flow line and flow vector deflections.

The following information is used in the Darcy's Law calculation to determine the amount of groundwater to be pumped from the site.

Darcy's Law Equation: Q=KIA

Where: Q=Groundwater Discharge into the Barrier Wall

K=Aquifer Hydraulic Conductivity (1E-1 cm/sec or 285 ft/day)

I=Groundwater Gradient (Average of PZ-5 U/D and PZ-8 U/D)

A=Groundwater Discharge Area (209,522 square feet)

Once the total groundwater discharge (Q) has been calculated using the above calculation, this value is used in the control scheme for each pump. Detailed information on the equipment, operational procedures, and maintenance program for the overall GMCS is presented in Operations and Maintenance Manual for the site (Appendix B).

All groundwater extracted by the pumps is discharged to the P-Chem plant for pretreatment and then to the ABRTF for final treatment and eventual discharge to the Mississippi River through American Bottoms' diffuser. Since the pumps became operational in 2004, approximately 1.6 billion gallons of water have been extracted and discharged for treatment. Following pretreatment at the P-Chem plant and final treatment at the ABRTF, the water extracted by the GMCS along with other wastewater streams being treated at the ABRTF are discharged into the Mississippi River. The discharge of treated water to the Mississippi River is permitted by National Pollutant Discharge Elimination System (NPDES) permit held by the ABRTF.

An American Sigma 900MAX automatic water sampler used to sample the effluent water was installed at the P-Chem plant discharge point at the request of the ABRTF. American Bottoms personnel are responsible for collecting any samples and checking the operation of this sampler.

5.2 GMCS EFFECTIVENESS MONITORING

The performance of the GMCS is evaluated by groundwater quality monitoring, groundwater level monitoring, and sediment and surface water monitoring.

A site plan showing the GMCS performance monitoring locations is provided in Figures 2-2 and 5-1.

5.2.1 Groundwater Quality Monitoring

Per the ROD, groundwater quality samples are collected quarterly downgradient of the Barrier Wall to determine mass loading to the Mississippi River resulting from any contaminants migrating through, past or beneath the barrier wall. Groundwater quality samples are collected from four monitoring well clusters identified in the ROD and shown in Figure 2-3. Each well cluster consists of monitoring wells screened in the Shallow, Middle and Deep Hydrogeologic Units. Samples are analyzed for VOCs, SVOCS, Herbicides, Pesticides and Metals. Total Organic Carbon (TOC) and Total Dissolved Solids (TDS) are also determined for each sample.

Downgradient groundwater samples for the purpose of performance monitoring are collected quarterly by Golder Associates (Golder). The results of these sampling events have been summarized in semi-annual reports submitted to USEPA Region V by Golder. A summary of the quarterly groundwater analytical data is provided in Appendix J of this document.

5.2.2 Groundwater Level Monitoring

Per the ROD, a groundwater level-monitoring program has been implemented to ensure acceptable performance of the Barrier Wall.

During initial operation of the GMCS, groundwater levels at the physical barrier were measured to determine if gradient control was achieved by comparing water-level elevations across the barrier wall and adjusting the pumping rates to ensure that gradients across the barrier wall are minimized. Piezometers installed at four locations (PZ-1 through PZ-4): 1) the northwest corner of the barrier wall, 2) the southwest corner of the barrier wall, 3) halfway between the north pumping well and the center pumping well and 4) half way between the south pumping well and the center pumping well were used to compare water level elevations inside and outside the barrier wall. Each piezometer cluster had one pair of piezometers located inside the wall (upgradient) and another pair or piezometers located outside the barrier wall (downgradient). Within each piezometers pair, one piezometer was screened across the Middle Hydrogeologic Unit (MHU) and one piezometer was screened across the Deep Hydrogeologic Unit (DHU). Piezometer installation logs are included in Appendix A of this document.

Using this system, river stage was the primary control for pumping rate while differential groundwater levels across the barrier was the secondary control. Since groundwater levels respond rapidly to river stage (typically within two to four hours), extraction well pumping rates were not adjusted to eliminate water-level differentials across the wall unless they persisted for one to two days. If differentials persisted for one to two days, pumping rates were increased until the differential was minimized. Pumping to adjust water-level differentials across the wall were only done when water levels inside the wall were higher than water levels outside the wall. If groundwater levels inside the wall were lower than those outside the wall, pumps were shut off until the differential across the wall was minimized. Pumping then resumed at a rate determined by river stage. Electronic water level recorders were installed in each piezometer and used to send water-level data to the pump controller.

Groundwater levels were also measured manually on a quarterly basis in the four piezometer clusters and existing wells B-21B, B-22A, B-24C, B25A, B-25B, B-26A, B-26B, B-28A, B-28B and B-29B to supplement gradient control information from the water-level piezometers.

After operating approximately 2 years using the originally planned control system, it was demonstrated that an excessive volume of groundwater was being purged from behind the barrier wall for treatment at the ABRTF. The groundwater elevation gauging and pump control systems were modified so that the amount of groundwater flowing into the barrier was pumped from the site by the extraction wells. Eight additional piezometers, PZ-5U, PZ-5D, PZ-6U, PZ-6D, PZ-

7U, PZ-7D, PZ-8U, and PZ-8D, were installed upgradient of Site R. to gauge groundwater elevations and control pump operation. The locations of these piezometers can be seen in Figure 2-3 and installation logs are included in Appendix A of this document. The pumping rates are currently controlled by automated monitoring equipment placed in piezometers PZ-5U, PZ-5D, PZ-8U, and PZ-8D. Groundwater elevations in these four piezometers are collected once per minute with an average water elevation value calculated every ten minutes for each piezometer. This water elevation is then used to calculate the groundwater gradient. The groundwater gradient values for the PZ-5 and PZ-8 pair is then averaged and applied to Darcy's Law as shown above.

In addition, as specified in the ROD, groundwater elevations are measured manually on a quarterly basis in the wells.

5.2.3 Sediment and Surface Water Monitoring

Surface water and sediment samples are collected semi-annually at Sediment Sampling Stations - 2, 3, 4, 5 and 9 (see Figure 5-1), where toxicity was observed in October/November 2000, and analyzed for VOCs, SVOCs, Herbicides, Pesticides and Metals. Constituent concentrations are plotted as a function of time and compared to the site-specific, toxicity-based, protective concentrations to determine progress toward achieving these targets.

Sediment and surface water sampling is conducted twice a year, once during the summer low flow period and once during the winter low flow period. It is anticipated that this sampling program will be implemented for a period of five years.

At this point, five surface water and sediment sampling events have been conducted since the GMCS became operational. Sampling events have occurred during September 2005, March 2006, September 2006, March 2007, and September 2007. During each of these sampling events, surface water and sediment samples collected from five sampling locations immediately adjacent to Site R, stations PDA-2, 3, 4, 5 and 9. During the September 2005 sampling event, samples were also collected from three locations downgradient of Site R at stations R3AM, R3BM and one upgradient location PDA-9A.

Results of these semi-annual surface water and sediment sampling events are summarized in semi-annual reports submitted to USEPA Region V. These reports are included in Appendix K of this document.

5.3 CONTRACTOR'S QUALITY CONTROL PLAN

The contractor was required to submit a Barrier Wall Construction and Quality Control Plan. This plan described the contractor's quality control organization, control procedures, reporting procedures, list of equipment, methods of construction, and a general materials testing log for the construction of the Barrier Wall.

The Contractor's Barrier Wall Construction and Quality Control Plan is presented in Appendix L. No substantial problems or deviations of the plan occurred.

5.3.1 Materials Quality Control

5.3.1.1 Slurry

Fresh slurry was mixed in a high shear venturi mixer, and had to be allowed enough time to hydrate to have a viscosity of 40 seconds and meet filtration criteria before placing into the trench excavation.

Trench slurry or reconditioned slurry consisted of a stable suspension of powdered bentonite, natural fines, natural sand, and water. Additives to reduce the capacity for suspending sand in the slurry were not permitted. The properties of the slurry were monitored per the specifications. The contractor performed remedial actions such as agitating the ponds or adding water as necessary. The contractor used a mechanical de-sander when the trench slurry required de-sanding or thinning. In-place trench slurry was typically sampled from a location within 100 ft of the excavation toe. The slurry was sampled from 10 ft below the slurry surface and from 10 ft above the trench bottom. Slurry testing results are presented in Appendix M.

5.3.1.2 Backfill Material

Samples were collected from the mixing area, or as directed by the Owner. Backfill samples were labeled with sample number, batch, and date and time sampled. If samples were collected from the trench, sampling station and depth were recorded.

The minimum number of Quality Control tests to be performed by the Contractor was as described below. Testing was not required if backfill mixing was not occurring. The Contractor performed additional tests to confirm mix proportions and bentonite addition as necessary, or as directed by the Owner.

Test	Volume of Prepared Backfill
Gradation	800 cy or 1 per day min.
Bulk Wet Density	300 cy or 2 per day min.
Water Content	300 cy or 2 per day min.
Slump	300 cy or 2 per day min.
Permeability	1,200 cy or 1 per week min.

Materials used for backfill preparation consisted of selected trench excavation spoils, bentonite, bentonite slurry, and imported clay fill (if required) thoroughly blended to a uniform distribution of particle sizes and consistency. The proportioning and mixing methods and procedures had to provide a uniform distribution of all materials throughout. The contractor managed and blended excavation spoils with dry bentonite and imported clay as required.

Daily backfill testing, permeability, and gradation test results for backfill are presented in Appendix N.

5.3.2 Installation Quality Control

Tests and measurements were conducted by the Contractor as required by the barrier wall specifications. (A copy of the specifications is included in Appendix F.) Data sheets for tests and measurements were maintained on a current basis at the job site. Quality control test results were available to the Owner's representatives on a daily basis or more frequently if requested. The Contractor assisted the Owner's representatives in performance of the quality assurance testing for quality assurance and documentation purposes that were required. All project specifications were reviewed and approved by the U.S. EPA. The U.S. EPA also had essentially full time oversight consultants observing all aspects of the project.

A Construction Quality Assurance (CQA) Consultant was responsible for observing and documenting activities related to the quality assurance of the project elements on behalf of Solutia. URS Corporation was hired to be the CQA Consultant. The CQA Consultant prepared reports and logs as necessary to summarize work activities, measurements, and test results associated with the installation of the project elements.

5.3.3 Temporary Stockpile Cover

Tests and measurements were conducted by the Contractor for the HDPE liner placed on the temporary stockpile. Data sheets for tests and measurements were maintained on a current basis at the job site. Quality control test results were available to the Owner's representatives on a daily basis or more frequently if requested. The Contractor assisted the Owner's representatives in performance of the quality assurance testing for quality assurance and documentation purposes that were required.

5.4 GROUNDWATER MITIGATION CONTROL SYSTEM

In addition to the barrier wall; extraction wells, piezometers, piping, and a monitoring system were installed at the site. The monitoring system consists of an automated pumping control system which controls the extraction wells at the site. Groundwater is pumped from the site to the off-site treatment facility. The system is designed to operate over a range of pumping rates between 0 to 700 gallons per minute per extraction well. The system is functioning. Details about the operation of the system can be found in the latest edition of the Operation and Maintenance Plan (Appendix B).

5.5 QUALITY ASSURANCE/QUALITY CONTROL AND USEPA OVERSIGHT

The Quality Assurance/Quality Control (QA/QC) program being implemented during operation of the GMCS is described in the documents entitled *Groundwater Migration Control System, Sauget Area 2 Superfund Site, Volume 3A, Field Sampling Plan* dated January 31, 2003 and *Groundwater Migration Control System, Sauget Area 2 Superfund Site, Volume 3B, Quality Assurance Project Plan* dated January 31, 2003 approved by EPA Region V. The QA/QC procedures specified in these documents ensures that the remedial action is executed in a manner consistent with the requirements specified in the ROD.

Field activities relating to the construction and ongoing performance monitoring of the GMCS have been and will be monitored by USEPA Region V or their designated Oversight Consultant. Currently, CH2M Hill is contracted by USEPA to provide oversight of ongoing effectiveness monitoring and O&M tasks relating to the GMCS. In addition, CH2M Hill provided daily oversight services during all historic GMCS construction activities.

Copies of all semi-annual monitoring reports as well as pertinent operation and maintenance document are provided to USEPA or CH2M Hill. In addition, all analytical data pertaining to performance monitoring is submitted to and reviewed by USEPA or their designee.

6.1 RA CONTRACT INSPECTIONS

Routine inspections have been performed at the site. The frequency and types of inspections are listed in the Operations and Maintenance Plan (Appendix B). As an inspection is being performed, a Field Service Report Form is filled out. A compilation of the Field Service Report Forms completed to date are included in Appendix O. It is intended that items that need addressing are completed when the issue is discovered. Therefore, there are no open issues regarding these inspections.

Construction was consistent with the ROD and design plans and specifications.

6.2 HEALTH AND SAFETY REQUIREMENTS

Adherence to health and safety requirements was maintained during the construction of the Barrier Wall. There were a few injuries during the construction process. One man twisted his knee while putting on tyvek. Another man twisted a previously injured knee while walking on the site. A third man injured his elbow while pulling on a piece of scrap plastic.

6.3 INSTITUTIONAL CONTROLS

Disturbed areas were reseeded and the pumps have been operational since 2005. Groundwater is being pumped using the three extraction wells, and transferred to the off-site treatment plant. The quantity of flow has been determined by the piezometric water levels measured in the piezometers. An automated monitoring system is measuring the pumps and flows. Details of the institutional controls are included in the Operations and Maintenance Plan (Appendix B).

6.4 EXTRACTION WELL STEP TEST

A series of tests were conducted on the GMCS extraction wells between March 21 and April 12, 2005. The objectives of the tests were to evaluate the amount of sand being produced from the three extraction wells, to estimate the efficiency of the wells, and to estimate the hydraulic conductivity of the aquifer within the Barrier Wall. A draft technical memorandum addressing this topic is included as Appendix P.

6.5 PRE-CERTIFICATION INSPECTION

The Pre-Final Inspection was conducted on June 28, 2005. There was only one item that was identified as requiring completion. The item was that a pressure test on the discharge pipeline needed to be completed. The only other punch list items were identified as Operations and Maintenance tasks, and were as follows:

- Inspection of the pitless adapter in one or both of EW-1 and EW-2.

- Comparison over time of the flow meter readings from the totalizing flow meter at the POTW discharge point with the readings from the individual flow meters on each of the extraction wells.
- Development of well abandonment plan for the wells on Site R that will not be used in the future.
- Reseeding the disturbed areas on the site in the fall of 2005.

These items have been addressed. See Appendix Q for the proposed well abandonment plan. Given the minor nature of items in the Pre-Final Inspection, a final inspection was not performed.

6.6 FINAL REMEDIAL ACTION CERTIFICATION

See the following page.

Final Remedial Action Certification

We certify that, to the best of our knowledge, the remedial action described in this report was completed in full satisfaction of the requirements of the Administrative Order for Remedial Design and Remedial Action issued by the U.S. EPA on September 30, 2002 (Docket No. V-W-'02-C-716).

Steven D. Smith
Project Coordinator

Richard S. Williams, P.E.
Project Manager

7.1 ACTIVITIES FOR POST-CONSTRUCTION

The amount of groundwater that flows into the barrier wall should equal the amount of groundwater that is pumped from the site by the extraction wells – thus preventing groundwater from mounding up behind the barrier wall and flowing out around the edges of the wall.

The following items are included in the operation and maintenance of the system:

- Data Management
- Extraction Wells and Extraction Well Pumps
- Flow Meters
- Electric Valve Actuators
- Variable Frequency Drives/Panels
- Equipment in Control Building
- Piezometers and Wells
- Sediment and Surface Water Sampling
- Well Sampling
- Site Inspection

Specific items to be inspected and the schedule are included in the Operations and Maintenance Plan (Appendix B).

7.2 POTENTIAL PROBLEMS WITH ACTIVITIES

The Groundwater Migration Control System is a complex system made up of numerous components. Each individual component of the system could have operational problems at some point during operations. As a result, the operation and maintenance guides provided by the manufacturers will be used for troubleshooting when there are problems with equipment operation.

To ensure that problems within the system are identified in a timely manner, project data are reviewed weekly. There are also alarms set up in the system that notify designated individuals if the system does not appear to be functioning properly. Alarm descriptions are as follows:

- Flow Alarm – No flow or low flow condition.
- VFD Fault Alarm – Variable frequency drive failed.

- Leak Alarm – Flow from extraction wells greater than total seen at outlet flow meter.
- Emergency Shutdown Alarm – System manually shut down for emergency.
- High Pressure Alarm – High Pressure limit exceeded.
- Vault Flood Alarm – Water within vault exceeds one foot in depth – emergency system shutdown.
- Flood Alarm – River is at flood stage.
- Remote Off Alarm - System Shutdown remotely by phone.

Corrective action is the process of identifying, recommending, approving and implementing measures to counter unacceptable procedures or out-of control performance, which can affect data quality. Corrective action can occur during any field activities; data analysis and assessment activities; or system analysis and assessment activities. Corrective actions proposed and implemented are documented in the regular quality assurance reports. Appendix O contains Field Service Reports generated to date.

7.3 FUTURE GROUNDWATER

As stated previously, the groundwater and surface water restoration is not the aim of the interim RA for OU-2. The RI/FS for OU-1 will address what additional remedial actions will be appropriate for the Area 2 sites.

8.1 ESTIMATED COSTS IN THE ROD

Estimated costs in the ROD are as follows:

Institutional Controls = $248,181

Monitoring = $1,845,527

Barrier = $7,045,794

Groundwater Treatment = $17,446,864

30-Year Present Value Cost = $26,586,366

8.2 ACTUAL AND CURRENTLY ESTIMATED FUTURE COSTS

The estimated design, construction, construction management, and CQAP costs for the installation of the wells, piping, monitoring system, and barrier wall was approximately $25,000,000. A unit cost of approximately $7,600 per linear foot of wall was incurred for construction.

Operation and maintenance costs have been approximately as follows:

Year 2003 = $827,000 (mid-July through December)

Year 2004 = $3,226,000

Year 2005 = $3,900,000

Year 2006 = $2,216,000

Year 2007 = $2,200,000

Year 2008+ = $2,200,000 per year for the next 25 years

The ROD was issued in 2002. Therefore costs were adjusted to a present value for the year 2002 using a rate of inflation of 4%. The 30-Year Present (2002) Value Cost = $63,510,681.

8.3 MAJOR DISCREPANCIES BETWEEN ROD ESTIMATES AND CURRENT ESTIMATES

The actual cost of the Barrier Wall construction was $25,000,000. The estimate in the ROD was approximately $9,000,000. The reasons for the difference include:

- Overly optimistic construction rate assumed by the contractor;

- Extensive ledge rock being present above the bedrock, which required extensive additional construction time to break up and remove;
- Construction was not able to be conducted during the winter months as planned;
- One month of construction was lost cleaning the Barrier Wall backfill after the winter shutdown; and
- Unstable soils (due to a former fly-ash pond) delayed construction.

The current estimated cost of the 30-year O&M is $63,500,000. The estimate in the ROD was approximately $17,500,000. The actual cost of future O&M and treating the groundwater is estimated at approximately $2,200,000 per year (in 2008 dollars). The estimated costs are as follows:

P-Chem Plant Charges	$650,000
American Bottoms Charges	$1,200,000
O&M Charges	$350,000
Total Yearly Estimate	$2,200,000

The project parameters were sufficient for the construction performed at the site. Approximately 3300 feet of barrier wall with depths up to 143 feet was installed at the site. In addition, extraction wells and piezometers were installed and are acting appropriately.

Installation of four sets of piezometers were completed prior to excavation of the Barrier Wall. The piezometers became obstructions for barrier wall construction and were always at risk during wall installation. It would have been better to have installed them after completion of the Barrier Wall.

During backfill placement, a blockage was observed in the north leg of the Barrier Wall which prevented backfill materials from advancing. The blockage was determined to be a partial wedge left in place. The blockage was discovered and located by using the QA Barrier Wall backfill placement tracking system. The contractor was able to successfully remove the blockage and resume construction activities.

A lesson learned during construction was the need of a second desanding unit. A desanding unit was used to lower the sand content within the slurry when construction was nearing completion for each leg. Due to debris suspended in the slurry, the intake pipe to the desander would become plugged. This plugging resulted in down time while the contractor cleaned the intake. The sand content did not create an issue during construction activities, but a second desanding unit would have been useful to limit extended down time as well as increase the amount of sand removed from the slurry.

The most pronounced lesson learned after construction of the barrier wall was completed, is that the original control logic set forth in the Record of Decision was inappropriate. The purpose of the GMCS, both in the Focused Feasibility Study and the ROD, is to pump out of the GMCS groundwater that naturally flows into the U-shaped Barrier Wall.

The control methodology set forth in the ROD contemplated the GMCS keeping the groundwater elevation inside (upgradient) the Barrier Wall at the same elevation (or lower) as the groundwater downgradient of the wall. During a 90 day Interim Operating Periond #1 (IOP #1), it was demonstrated that the GMCS could not meet this requirement at low river elevations. Attempting to do so resulted in significant over-pumping compared to the GMCS objective. Numerous technical meetings and submissions to EPA, including an IOP #2 and IOP #3, resulted in the development of an appropriate control methodology for the GMCS. The operation of the GMCS is now controlled by Piezometer pairs PZ5 and PZ8 and Darcy’s Law (as previously described) to calculate the amount of groundwater flowing into the Barrier Wall.

Contact information for the major design and remediation contractors, USEPA, and others are included in Table 10-1.

ASTM D5084. Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials using a Flexible Wall Permeameter.

ASTM C143. Standard Test Method for Slump of Hydraulic Cement Concrete

EPA Docket No. R8H-5-00-03, May 3, 2000 RCRA 3008(h) Consent Order, Solutia Inc, ILD 000 802 702.

Golder Associates, June 2005 Quarterly Groundwater Monitoring Event, Sauget Site R – Area 2, Sauget, IL, January 24.

Golder Associates, September 2005 Quarterly Groundwater Monitoring Event, Sauget Site R – Area 2, Sauget, IL, March 8, 2006.

Golder Associates, December 2005 Quarterly Groundwater Monitoring Event, Sauget Site R – Area 2, Sauget, IL, May 26, 2006.

Golder Associates, March 2006 Quarterly Groundwater Monitoring Event, Sauget Site R – Area 2, Sauget, IL, July 11, 2006.

Golder Associates, June 2006 Quarterly Groundwater Monitoring Event, Sauget Site R – Area 2, Sauget, IL, October 3, 2006.

Golder Associates, September 2006 Quarterly Groundwater Monitoring Event, Sauget Site R – Area 2, Sauget, IL, January 27, 2007.

Golder Associates, December 2006 Quarterly Groundwater Monitoring Event, Sauget Site R – Area 2, Sauget, IL, May 3, 2007.

Golder Associates, March 2007 Quarterly Groundwater Monitoring Event, Sauget Site R – Area 2, Sauget, IL, June 20, 2007.

Golder Associates, June 2007 Quarterly Groundwater Monitoring Event, Sauget Site R – Area 2, Sauget, IL, September 20, 2007.

Golder Associates, September 2007 Quarterly Groundwater Monitoring Event, Sauget Site R – Area 2, Sauget, IL, January 9, 2008.

Golder Associates, December 2007 Quarterly Groundwater Monitoring Event, Sauget Site R – Area 2, Sauget, IL, March 4, 2008.

Grimley, D.A. and S.W. Lepley, 2005, Surficial Geology of Wood River Quadrangle, Madison County, Illinois: Illinois State Geological Survey, Illinois Preliminary Geologic Map, IPGM Wood River-SG, 1:24,000.

URS Corporation. February 2008. Remedial Investigation Report, Sauget Area 2, Sauget, IL (URS, February 2008).

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URS Corporation. April 2002b. RI/FS Support Sampling Plan, Sauget Area 2 Sites, Sauget, IL. (URS, April 2002b).

URS Corporation, 2002. Groundwater Migration Control System Remedial Design/ Remedial Action Workplan.

USEPA. July 2007. Close Out Procedures for National Priorities List Sites.

USEPA. September 2002. Record of Decision (ROD) for the Groundwater Operable Unit (OU-2), Sauget Area 2 Superfund Site, Sauget, IL. (USEPA, September 2002).

USEPA. October 2002. Administrative Order of Consent (the Order Requiring Remedial Design for the Interim Groundwater Remedy). (USEPA, October 2002).

USEPA. November 2000. Administrative Order by Consent (Order Requiring RI/FS). (USEPA, November 2000).

Table 2-1
Extraction Well Installation Data
Barrier Wall Remedial Action Completion Report
Sauget, Illinois
URS Job #21562001

Well	Elevation (ft, NGVD)					Length (ft)			
	Ground Surface	Centerline of Discharge Pipe	Top of Screen (Exposed)	Bottom of Screen	Bottom of Well	Casing (bgs)	Exposed Screen	Blank	Well OD (in.)
EW-1	422.02	417.29	369.0	291.0	285.8	53.0	78.0	5.2	12.75
EW-2	418.53	415.26	380.3	313.6	308.5	41.5	63.4	5.1	10.75
EW-3	420.58	416.26	364.1	294.6	289.3	56.7	69.4	5.3	12.75

Notes: Well installation data are from Well Completion Records prepared by Dave Meyer, Layne-Western Division, Layne Christensen Company, July 28, 2003

Table 2-2
Pump Installation Data
Barrier Wall Remedial Action Completion Report
Sauget, Illinois
URS Job #21562001

Well	Top of Riser Elevation (ft, NGVD)	Elevation (ft, NGVD)		Drop Pipe Dia. (in.)	Grundfos Model No.	Flow (gpm)	Efficiency (%)	Shutoff Head (ft)	Motor HP
		Discharge (centerline)	Pump Intake						
EW-1	422.72	417.29	340	6	625S400-2-1	750	80	235	40
EW-2	419.84	415.26	337	5	475S400-3	750	73	310	30
EW-3	421.45	416.26	339	6	625S400-2-1	700	80	235	40

Table 10-1
Operable Unit Contact Information

EPA Region V
Nabil Fayoumi
77 West Jackson Blvd
Chicago, IL 60604
312-886-6840

USEPA Oversight
Clair (Morris) Aggett
CH2M HILL
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314-335-3039

IEPA
Sandra Bron
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Springfield, IL 62706
217-557-3199

Solutia Project Coordinator
Steve Smith
575 Maryville Centre Drive
P.O. Box 66760
St. Louis, MO 63141
314-674-4660

Solutia Project Manager
Richard Williams
R.S. Williams & Associates
W.G. Krummrich
500 Monsanto Ave.
Sauget, IL 62206
618-482-6340

Construction Manager
Richard Ashley
URS Corporation – Has since retired

Assistant Construction Manager
Tim Hicks
URS Corporation
1001 Highlands Plaza Drive West
Suite 300
St. Louis, MO 63110
314-429-0100

Table 10-1
Operable Unit Contact Information

Groundwater Migration Control System Designer
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St. Louis, MO 63110
314-429-0100

Designer for the Recovery Wells
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Golder
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Suite 100
St. Charles, MO 63301
636-724-9191

Construction Quality Assurance Consultant
Ray Scherrer
URS Corporation
1001 Highlands Plaza Drive West
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St. Louis, MO 63110
314-429-0100

Quality Assurance Lab
Greg Thomas
URS Corporation
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973-812-1818

Contractor
Dominique Namy
INQUIP
P.O. Box 6277
McClean, VA 22106
703-442-0143

Barrier Wall Designer
Peter Deming
Mueser Rutledge Consulting Engineers
14 Penn Plaza
225 West 34th Street
New York, NY 10122
917-339-9300

Table 10-1
Operable Unit Contact Information

Contractor Quality Control
Kevin Miller
8669 Olive Blvd
St. Louis, MO 63132
314-432-8073

Well Installers
Dave Meyer
Layne Christensen
2399 Cassens Drive
Fenton, MO 63026
636-343-3700

Earthwork for Stockpile
Paul Wagner
Pangea
2604 S. Jefferson Avenue
St. Louis, MO 63118
314-333-0600

Solidified Slurry Material in Stockpile
Ed Ballog
Philip Environmental Services
210 West Sand Bank Road
Columbia, IL 62236
618-281-7173

Stockpile Cap Installer
Bob Leppink
ENTACT & Associates
1010 Executive Court
Suite 280
Westmont, IL 60559
630-986-2900

Liner Subcontractor
Suvit Padrasi
Environmental Specialties International
7943 Pecue Lane
Suite A
Baton Rouge, LA 70809
225-291-2700

Table 10-1
Operable Unit Contact Information

Water Treatment Facility
George Schillinger
American Bottoms P-Chem Treatment Plant General Manager
One American Bottoms Rd.
Sauget, IL 62201
618-337-1710

SITE R
SAUGET, ILLINOIS

INDEX

GROUNDWATER MIGRATION CONTROL SYSTEM
AUTOMATED CONTROL AND MONITORING SYSTEM

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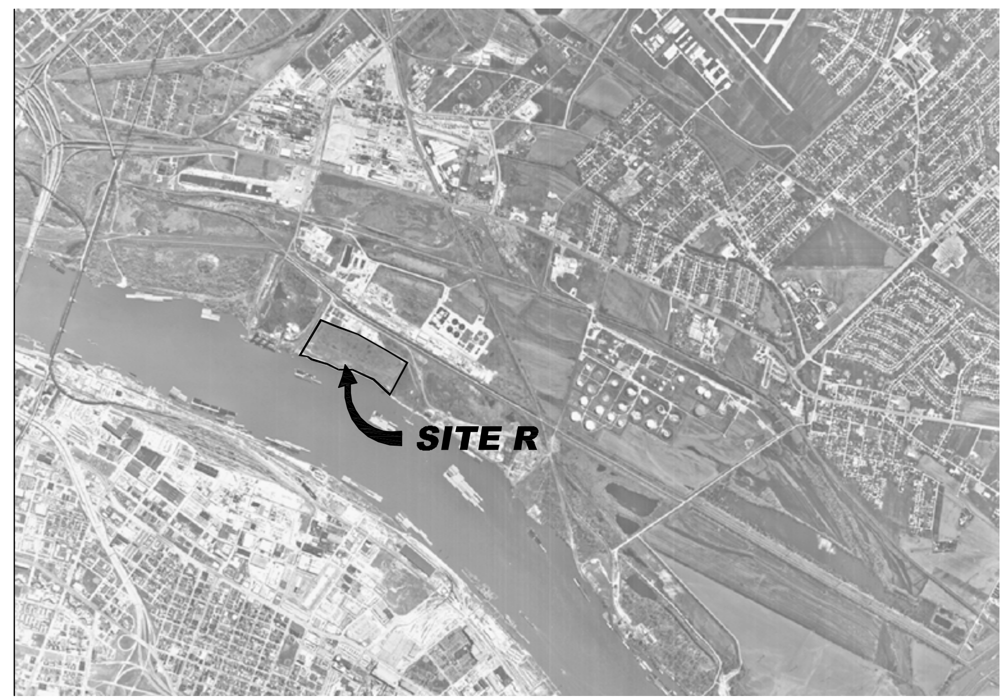
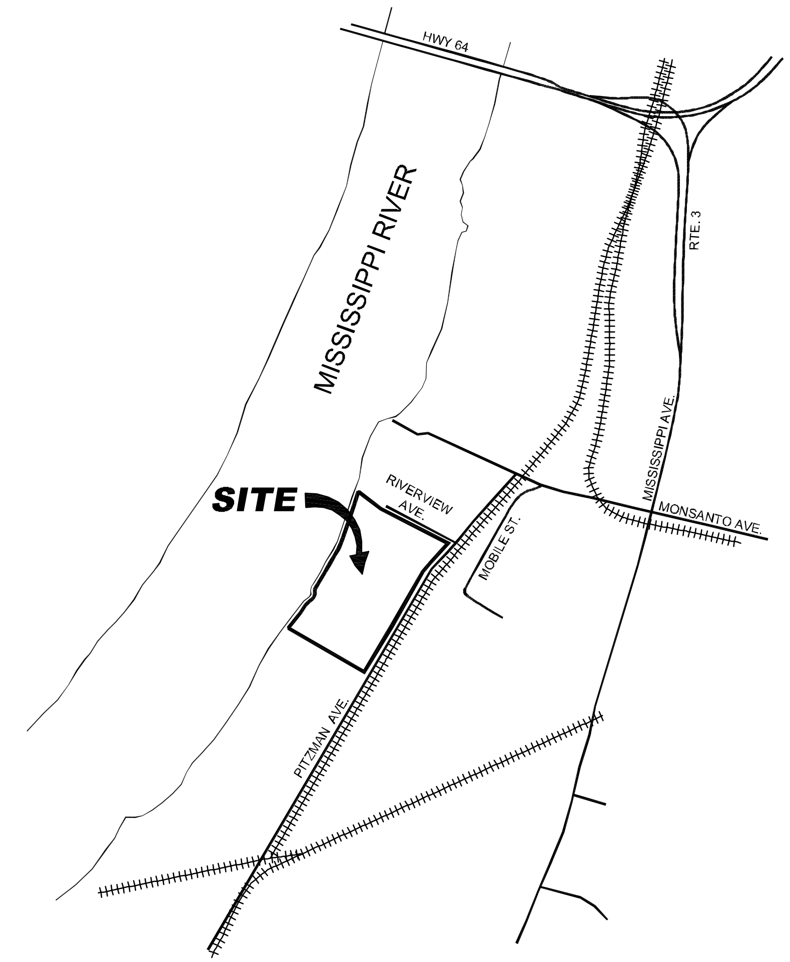
Applied Chemistry, Creative Solutions





LOCATION MAP

NOTE:
EXISTING SURFACE FEATURES HAVE BEEN PLOTTED FROM AN AERIAL SURVEY BY SURDEX. THE LOCATIONS OF UNDERGROUND UTILITIES, STRUCTURES AND FACILITIES HAVE BEEN PLOTTED FROM PLANS AND DRAWINGS OF EXISTING FACILITIES PROVIDED BY SOLUTIA. THEIR LOCATIONS MUST BE CONSIDERED APPROXIMATE ONLY. THERE MAY BE OTHER IMPROVEMENTS AND UTILITIES WITHIN THE PROJECT AREA, WHICH ARE NOT SHOWN. THE CONTRACTOR SHALL VERIFY, PRIOR TO EXCAVATION OR CONSTRUCTION, THE LOCATIONS, ELEVATIONS AND DIMENSIONS OF ALL EXISTING UTILITIES, STRUCTURES, WELLS AND OTHER FEATURES AFFECTING HIS WORK, WHETHER OR NOT SHOWN ON THE PLANS. USE OF A SUBSURFACE LOCATOR IS RECOMMENDED.

NO.	DATE	REVISION DESCRIPTION	APPROVED

URS
1001 Highlands Plaza Dr. West, Suite 300
St. Louis, MO 63110

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SEAL

DATE: 4/11/08
SCALE:
DESIGNED: RS
DRAWN: DJD
CHECKED:
SUBMITTED:

SOLUTIA™ Applied Chemistry, Creative Solutions

SOLUTIA INC.
575 MARYVILLE CENTRE DRIVE
ST. LOUIS, MO. 63141

GROUNDWATER MIGRATION CONTROL SYSTEM

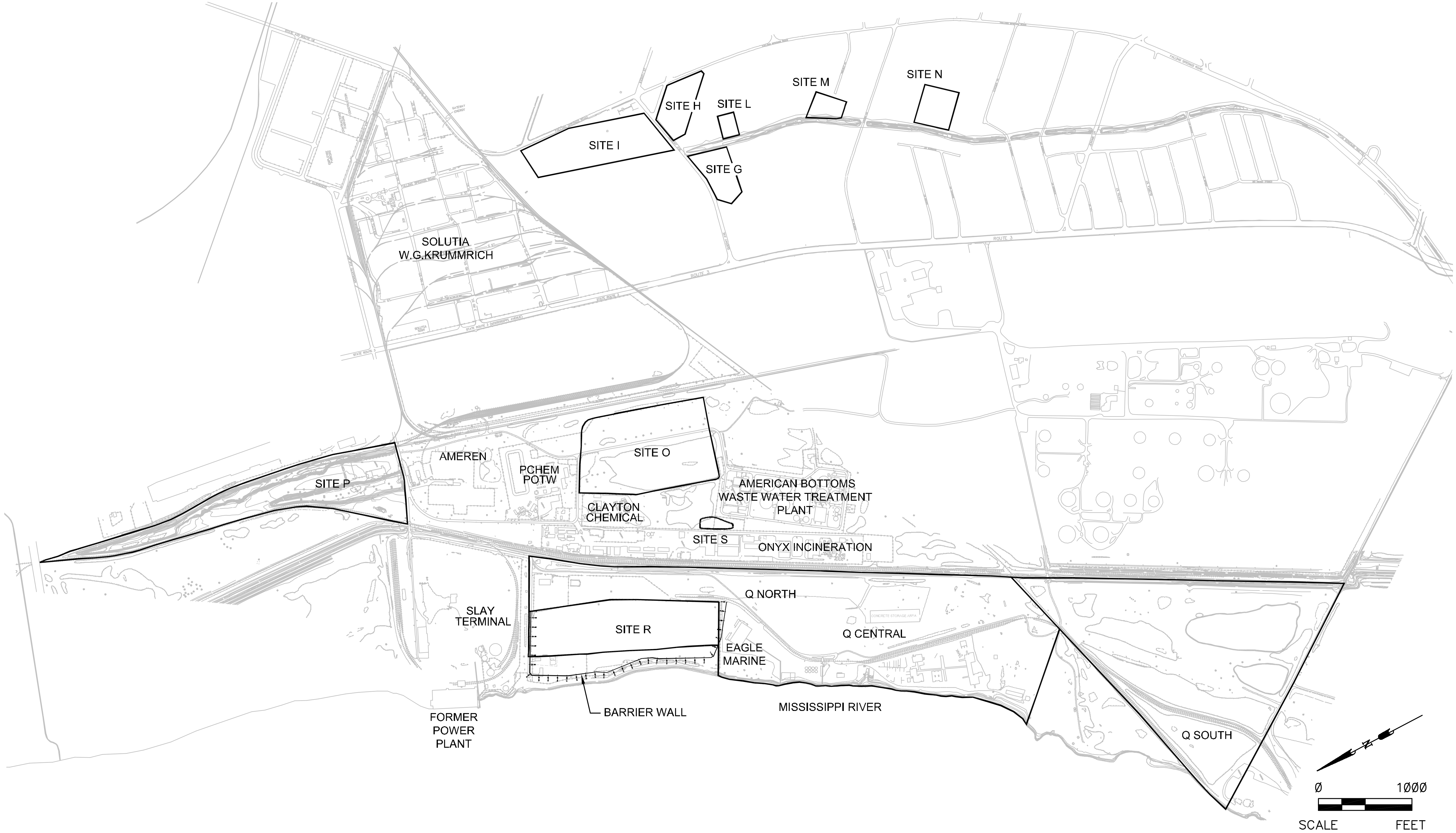
FINAL REMEDIAL ACTION COMPLETION REPORT

Site Location Map

PROJECT NO. 21562001

FIGURE NO. **1-1**

File: P:\ENVIRONMENTAL\21562001.00003 SITE R\DRAWINGS (4-11-08)\FIGURE 1-1 SITE LOCATION MAP.DWG Last edited: OCT. 07, 09 @ 3:28 p.m. by: david_deguire



File: P:\ENVIRONMENTAL\21562001.00003 SITE R\DRAWINGS (4-11-08)\FIGURE 2-1 PROPERTY BOUNDARIES.DWG Last edited: OCT. 07, 09 @ 3:30 p.m. by: david_deguire

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575 MARYVILLE CENTRE DRIVE
ST. LOUIS, MO. 63141

GROUNDWATER MIGRATION CONTROL SYSTEM

FINAL REMEDIAL ACTION
COMPLETION REPORT

Property Boundaries

PROJECT NO.
21562001

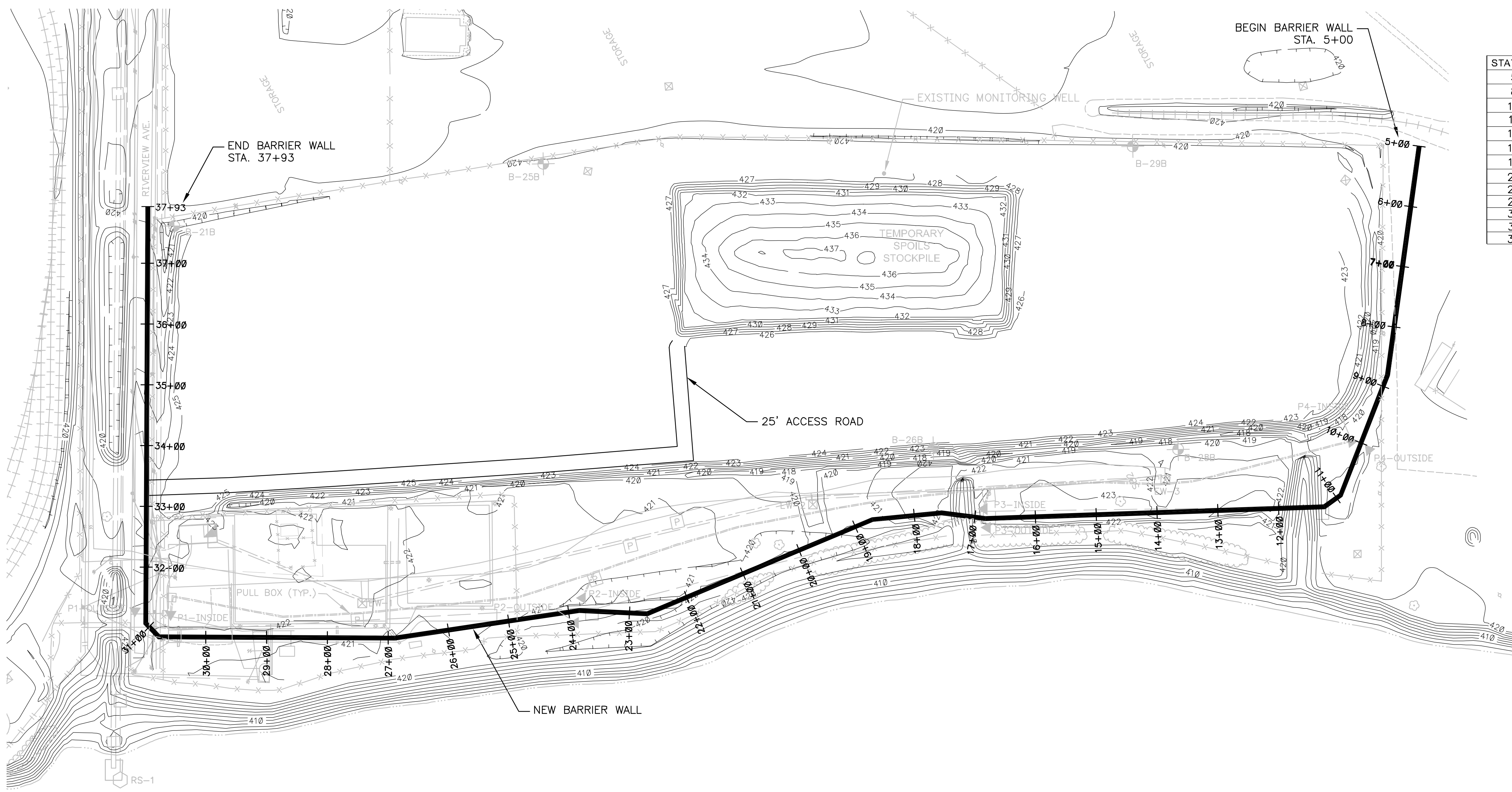
FIGURE NO.
2-1

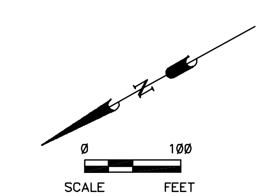
NOTES:
1) EXISTING SURFACE FEATURES HAVE BEEN PLOTTED FROM AN AERIAL SURVEY BY SURDEX. THE LOCATIONS OF UNDERGROUND UTILITIES, STRUCTURES AND FACILITIES HAVE BEEN PLOTTED FROM PLANS AND DRAWINGS OF EXISTING FACILITIES PROVIDED BY SOLUTIA. THEIR LOCATIONS MUST BE CONSIDERED APPROXIMATE ONLY. THERE MAY BE OTHER IMPROVEMENTS AND UTILITIES WITHIN THE PROJECT AREA, WHICH ARE NOT SHOWN.

2) AS BUILT INFORMATION WAS MADE BY ZAHNER & ASSOCIATES AND WAS PROVIDED BY SOLUTIA INC.

3) BARRRIER WALL LAYOUT COORDINATES ARE AS FOLLOWS:

STATION	NORTHING (FT)	EASTING (FT)
5+00	702093.32	2290630.87
8+80	702321.24	2290326.81
10+92	702484.17	2290191.57
11+25	702517.38	2290187.87
16+82	703013.51	2290440.68
17+55	703072.25	2290483.86
18+69	703177.29	2290529.50
22+70	703575.90	2290573.44
23+43	703671.30	2290632.46
26+89	703958.35	2290739.40
30+76	704296.37	2290929.08
31+07	704304.80	2290959.04
37+93	703969.63	2291557.27





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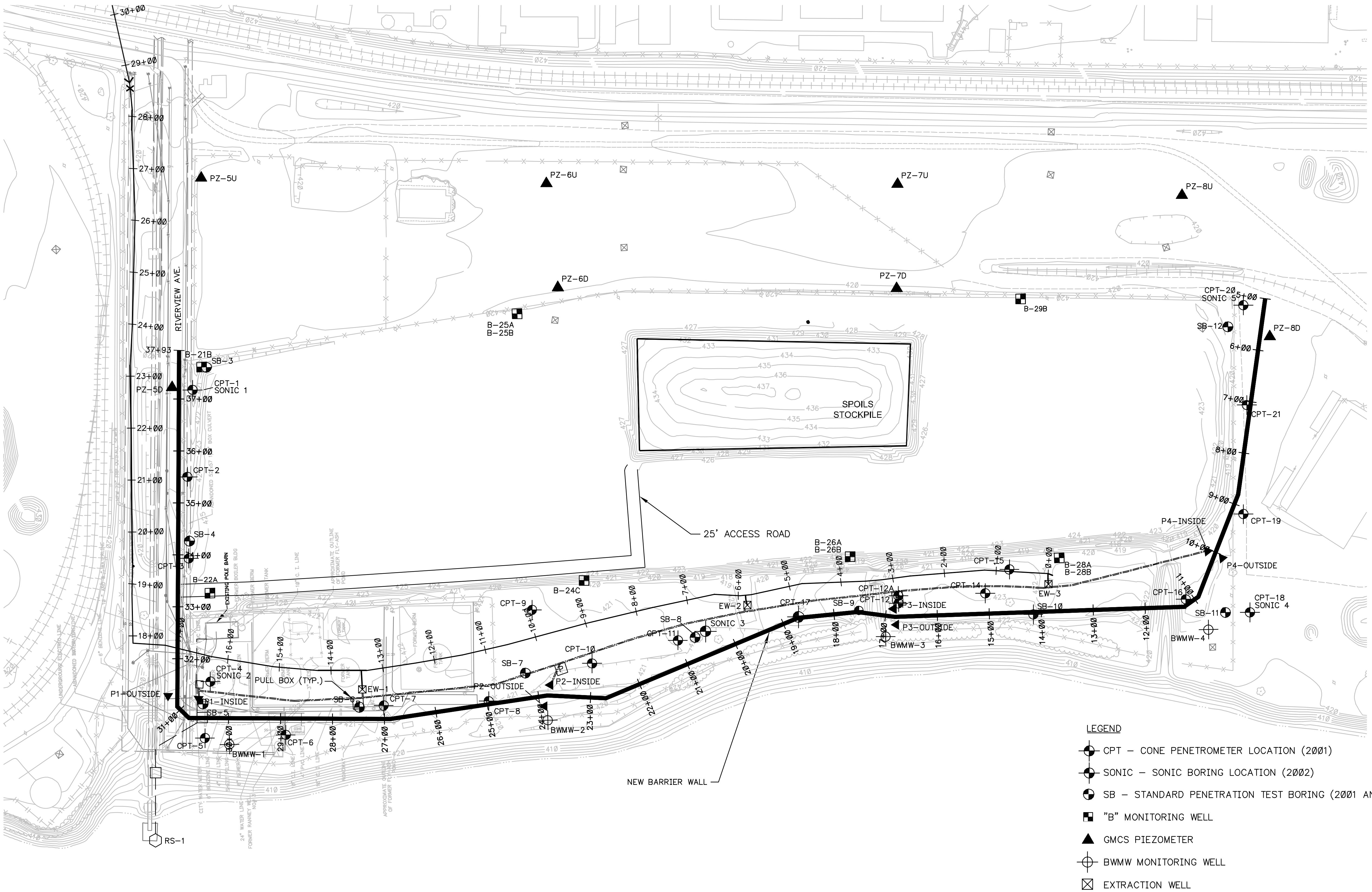
GROUNDWATER MIGRATION CONTROL SYSTEM
FINAL REMEDIAL ACTION COMPLETION REPORT
Barrier Wall Location

PROJECT NO. 21562001
FIGURE NO. 2-2

File: P:\ENVIRONMENTAL\21562001.00003 SITE R\DRAWINGS (4-11-08)\FIGURE 2-2 BARRIER WALL LOCATION.DWG Last edited: OCT. 07, 09 @ 3:31 p.m. by: david_dequire



NOTE:
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LEGEND
- CPT – CONE PENETROMETER LOCATION (2001)
- SONIC – SONIC BORING LOCATION (2002)
- SB – STANDARD PENETRATION TEST BORING (2001 AND 2002)
- "B" MONITORING WELL
- GMCS PIEZOMETER
- BWMW MONITORING WELL
- EXTRACTION WELL

0 100
SCALE FEET

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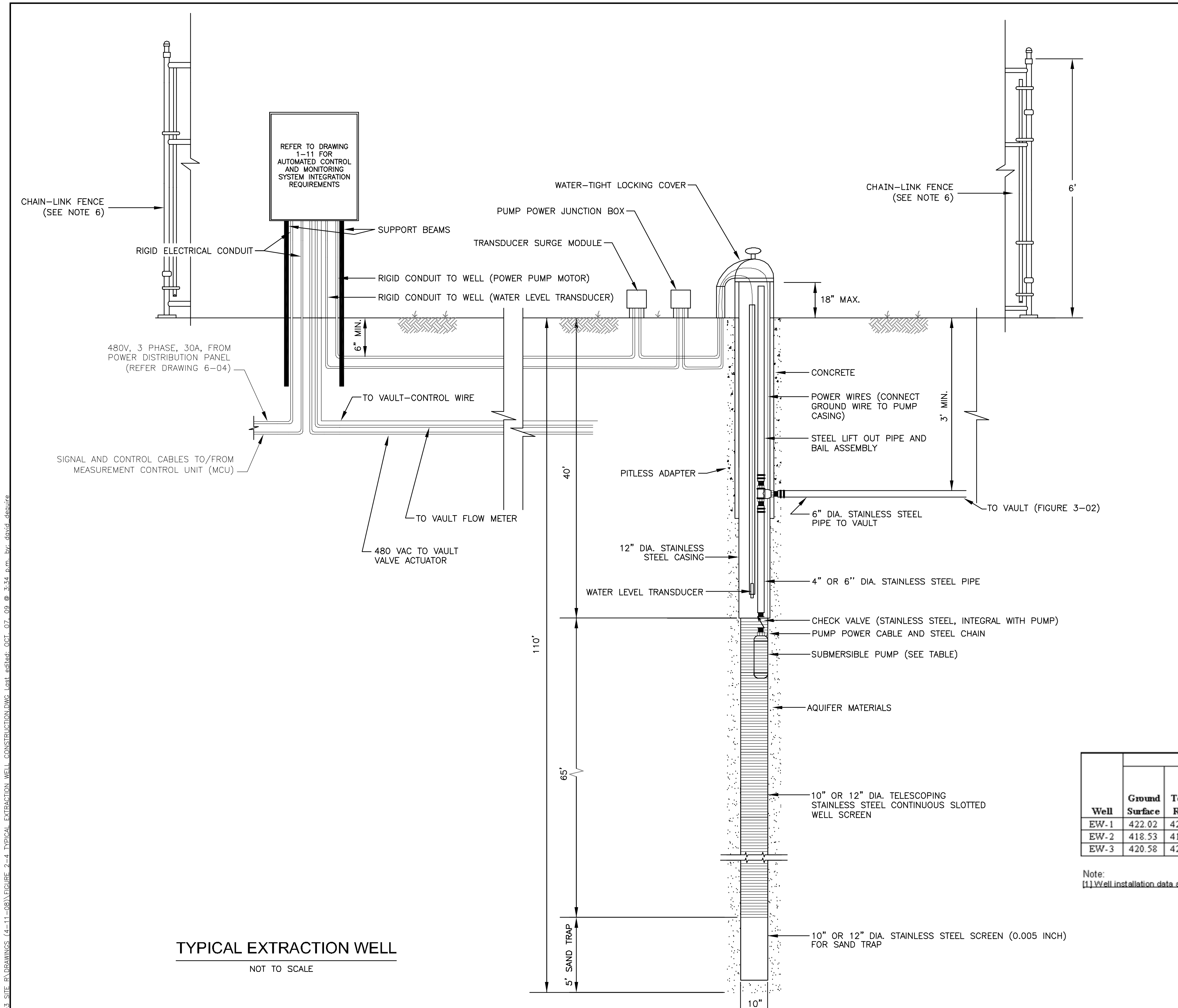
GROUNDWATER MIGRATION CONTROL SYSTEM
FINAL REMEDIAL ACTION COMPLETION REPORT
Well and Piezometer Location Map

PROJECT NO. 21562001
FIGURE NO. 2-3



TYPICAL EXTRACTION WELL

NOT TO SCALE

NOTES

1.) TYPICAL WELL CONSTRUCTION. ACTUAL PLACEMENT OF WELL SCREEN AND CASING WAS MODIFIED BY REMEDIAL DESIGNER BASED ON FIELD CONDITIONS.

2.) COMPLETION OF EXTRACTION WELLS WAS UNDER THE DIRECT SUPERVISION OF THE REMEDIAL DESIGNER OR OTHER QUALIFIED PROFESSIONAL DESIGNATED BY SOLUTIA. THE FINAL COMPLETION OF EXTRACTION WELLS WAS BASED ON ACTUAL CONDITIONS ENCOUNTERED DURING WELL CONSTRUCTION.

3.) SUPPORT PUMP AND DISCHARGE PIPING FROM TOP. PITLESS ADAPTER DOES NOT SUPPORT PUMP UNLESS PITLESS ADAPTER IS CONCRETED IN PLACE. STAINLESS STEEL CHAIN ATTACHES TO PUMP.

4.) ALL WIRING BETWEEN THE EXTRACTION WELLS AND CONTROL PANEL IS SUBMERSIBLE. CONNECTED WIRES TO WELL CONDUIT USING SEAL TIGHT CONNECTORS. PROVIDE ELECTRICAL BOX (NEMA 6)AT GROUND SURFACE SIZED TO STORE A MINIMUM OF 5 FEET OF EXCESS WIRES (SLACK) COILED NEATLY IN JUNCTION BOX FOR ADJUSTING DEPTH IN WELLS.

5.) PRESSURE TRANSDUCERS WERE INSTALLED IN EACH WELL ABOVE TOP OF PUMP IN ORDER TO GAUGE DRAWDOWN.

6.) CONTRACTOR INSTALLED A CHAIN LINK FENCE ENCLOSURE AROUND THE PERIMETER OF EACH WELL.

7.) SUBMERSIBLE PUMP PLACED WITHIN SCREEN AT DEPTH OF APPROXIMATELY 60 FEET BELOW GROUND SURFACE.

8.) EXISTING WELL EW–2 HAS 10.75–IN. O.D. CASING AND 10–IN. TELESCOPING WELL SCREEN.

Extraction Well Transducer Data

Piezometer	Top of Riser (TOR) Elevation (ft, NGVD)	Transducer Depth from TOR (ft)	Transducer Elevation (ft, NGVD)	(Geokon) Transducer Model
EW-1	422.72	65.02	357.7	4500S-50PSI
EW-2	419.84	68.59	351.25	4500S-50PSI
EW-3	421.45	64.35	357.1	4500S-50PSI

Pump Installation Data

Well	Elevation (ft, NGVD)		Drop Pipe Dia. (in.)	Grundfos Model No.	Flow (gpm)	Head (ft)	Efficiency (%)	Shutoff Head (ft)	Motor HP
	Discharge (centerline)	Pump Intake							
EW-1	417.29	340	6	625S400-2-1	750	150	80	235	40
EW-2	415.26	337	5	475S400-3	750	150	73	310	30
EW-3	416.26	339	6	625S400-2-1	700	150	80	235	40

WELL INSTALLATION DATA

Well	Elevation (Ft, NGVD)						Length (Ft)			Well OD (in.)
	Ground Surface	Top of Riser	Center-line of Disch. Pipe	Top of Screen (Exposed)	Btm of Screen	Btm of Well	Casing bgs)	Exposed Screen	Blank	
EW-1	422.02	422.72	417.29	369.0	291.0	285.8	53	78	5.2	12.75
EW-2	418.53	419.84	415.26	380.3	313.6	308.5	41.5	63.4	5.1	10.75
EW-3	420.58	421.45	416.26	364.1	294.6	289.3	56.7	69.4	5.3	12.75

Note:
[1] Well installation data are from Well Completion Records prepared by Dave Meyer, Layne-Western Division, Layne Christensen Company, July 28, 2003

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Golder Associates
St. Louis, Missouri

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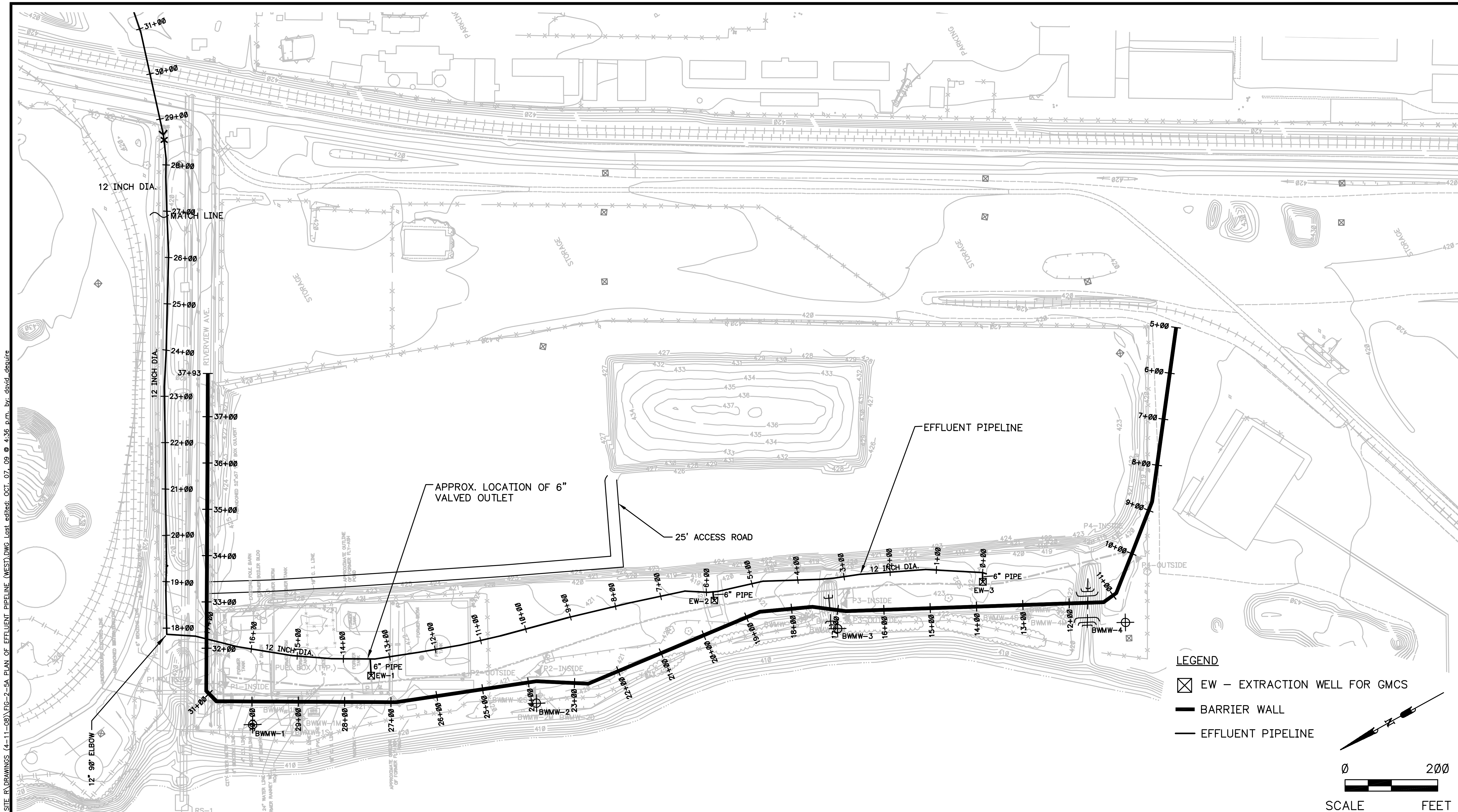
GROUNDWATER MIGRATION CONTROL SYSTEM
FINAL REMEDIAL ACTION COMPLETION REPORT
Typical Extraction Well Construction

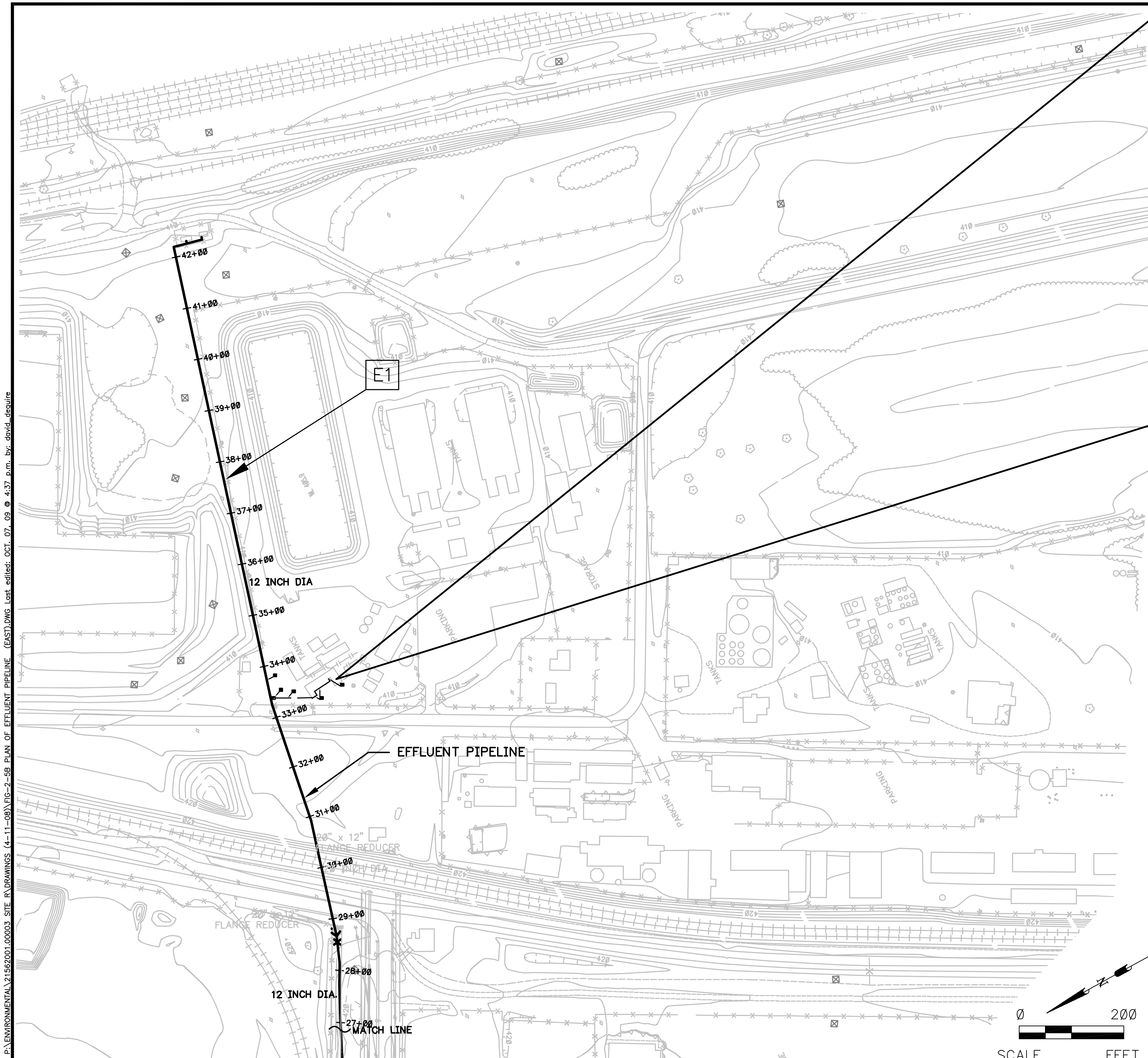
URS PROJECT NO. 21562001
DRAWING NO. 2-4

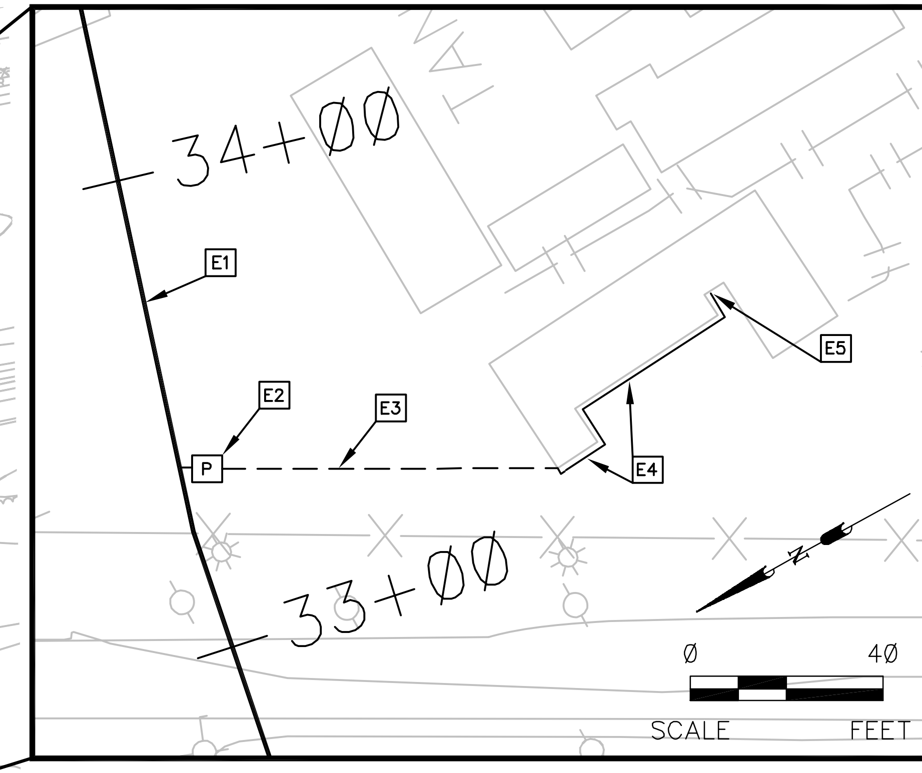


EXCAVATION PLAN FORMER PCB MANUFACTURING AREA W.G. KRUMMRICH FACILITY SAUGET, IL	PROJECT NO. 21562010

URS

DRN. BY: djd 5/20/08 DSGN. BY: kmb CHKD. BY:	Plan of Effluent Pipeline (West)	FIG. NO. 2–5A





ELECTRICAL NOTES:

E1 1-INCH HEAVY WALL HDPE-SR13.5 CONDUIT INSTALLED ALONGSIDE NEW 12-INCH EFFLUENT PIPE FOR FLOWMETER ANALOG WIRING.

E2 24" X 30" X 24" DEEP QUAZITE OPEN-BOTTOM PULLBOX FLUSH WITH GRADE AND GRAVEL DRAINAGE WERE INSTALLED ALONG WITH CONDUITS INTO BOTTOM OF PULLBOX USING WIDE-SWEEP BENDS. ANALOG CABLE FROM FLOWMETER LOOPED TO PLC THROUGH PULLBOX.

E3 1-INCH CONDUIT, WAS INSTALLED AT LEAST 36-INCHES UNDERGROUND FROM PULLBOX TO NORTHWEST CORNER OF STRUCTURE.

E4 UNDERGROUND CONDUIT TRANSITIONED TO 1-INCH ROB ROY PVC-COATED RIGID CONDUIT AND EXTENDED UPON CONCRETE WALL USING EXISTING STRUT, SUPPLEMENTED AS REQUIRED WITH ADDITIONAL CONDUIT SUPPORTS, TO PLC CABINET.

E5 CONDUIT EXTENDED UP INTO BOTTOM OF EXISTING PLC CABINET. WIRING FROM FLOWMETER AT PUMP DISCHARGE WAS PROVIDED TO ANALOG PLC INPUT CARD IN CABINET.

LEGEND

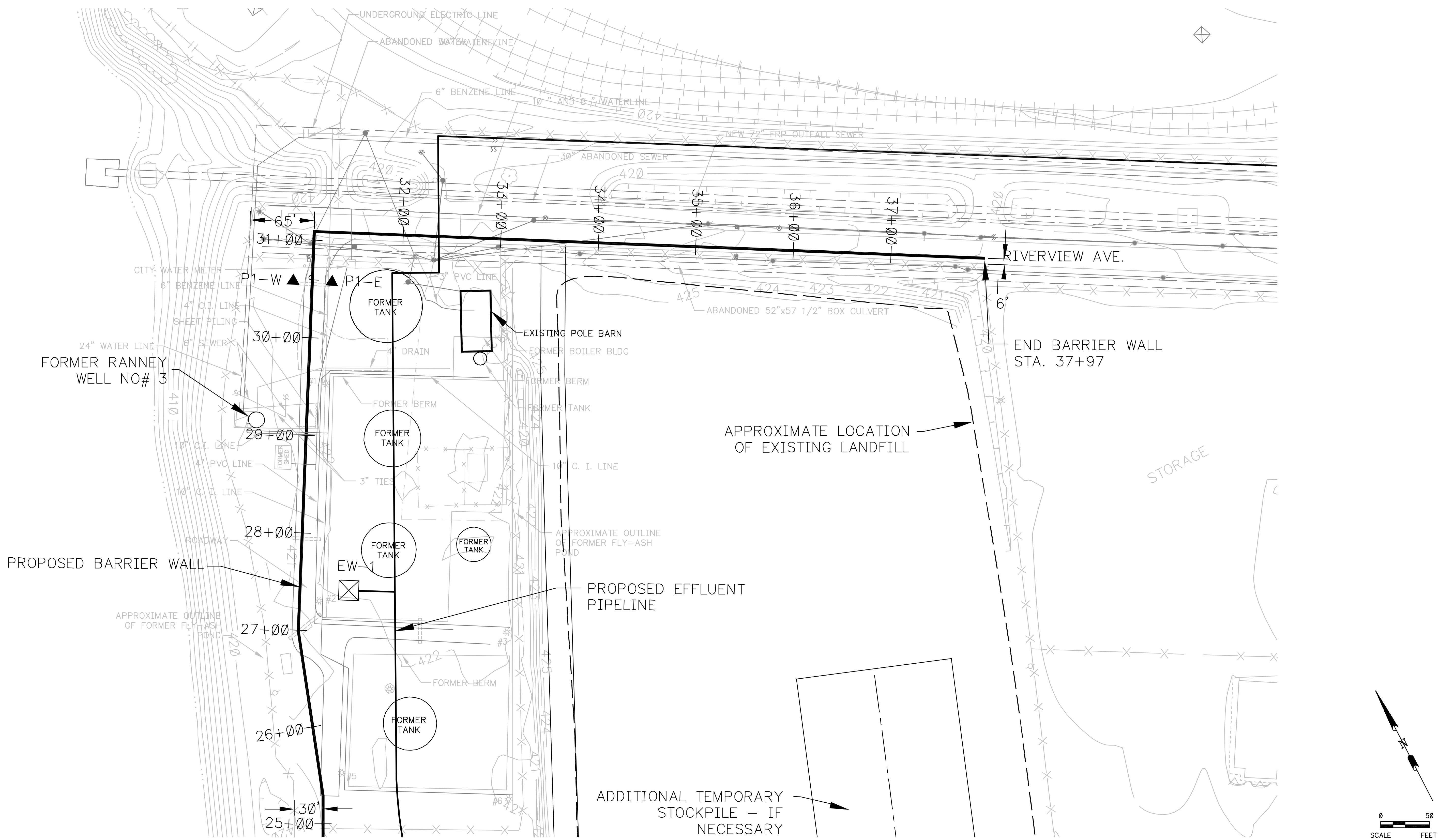
EFFLUENT PIPELINE

REDUCER

PLUG VALVE (BURIED)

EXCAVATION PLAN FORMER PCB MANUFACTURING AREA W.G. KRUMMRICH FACILITY SAUGET, IL		PROJECT NO. 21562010
URS		
DRN. BY: djd 5/20/08 DSGN. BY: kmb CHKD. BY:	Plan of Effluent Pipeline (East)	FIG. NO. 2-5B

File: P:\ENVIRONMENTAL\21562001.00003 SITE R\DRAWINGS (4-11-08)\FIG-2-5B PLAN OF EFFLUENT PIPELINE (EAST).DWG Last edited: OCT. 07, 09 @ 4:37 p.m. by: david_deguire



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PREPARED BY:

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2318 Millpark Drive St. Louis, MO. 63043 Tel: 314-429-0100 Fax: 314-429-0462

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GROUNDWATER MIGRATION CONTROL SYSTEM

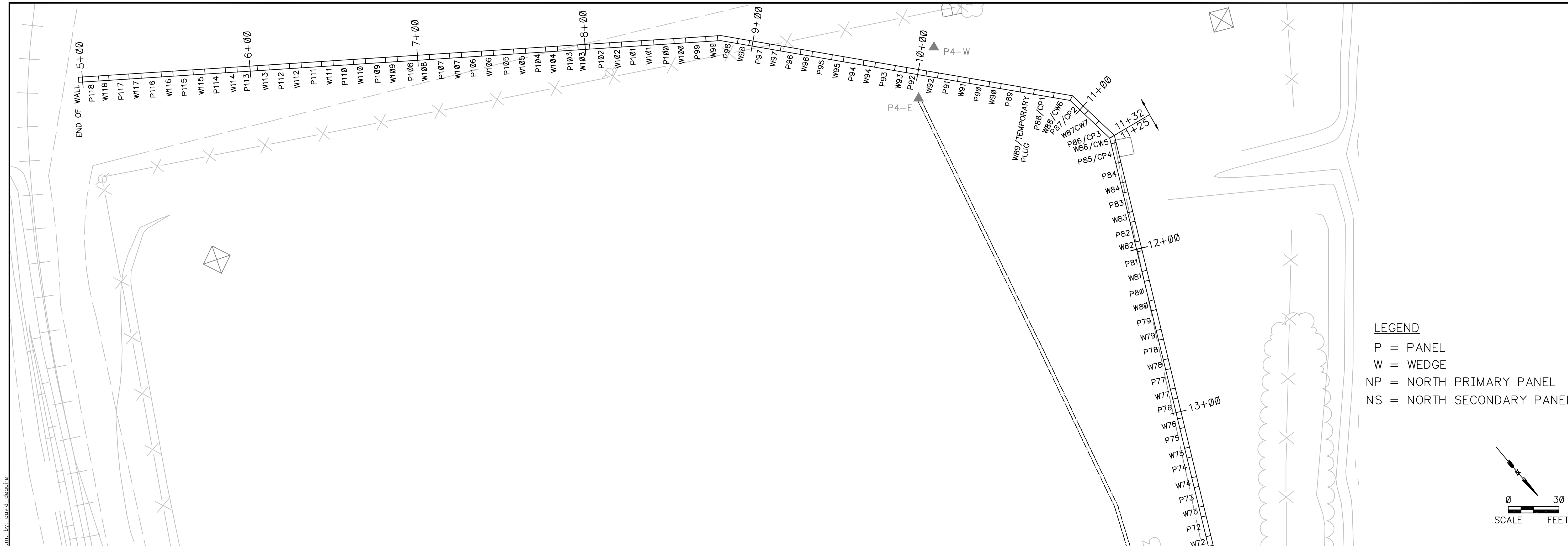
FINAL REMEDIAL ACTION COMPLETION REPORT

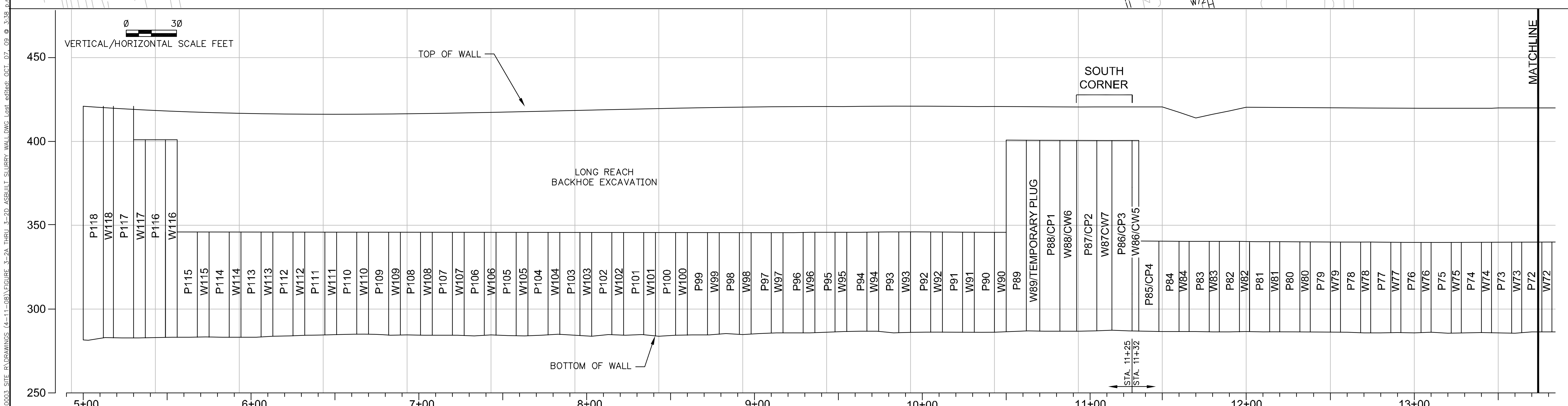
Barrier Wall Construction Obstructions

PROJECT NO. 21562001

SHEET NO. 3-1

File: P:\ENVIRONMENTAL\21562001.00003 SITE R\DRAWINGS (4-11-08)\FIGURE 3-1 BARRIER WALL CONSTRUCTION OBSTRUCTIONS.DWG Last edited: OCT. 07, 09 @ 3:35 p.m. by: david_deguire





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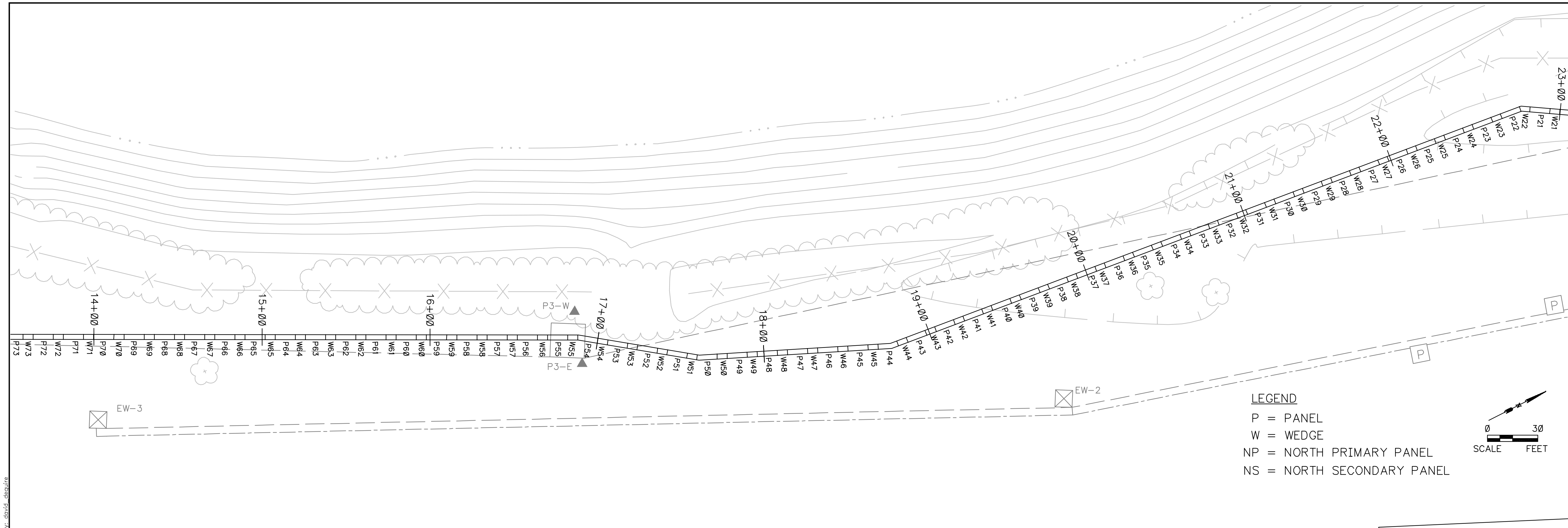
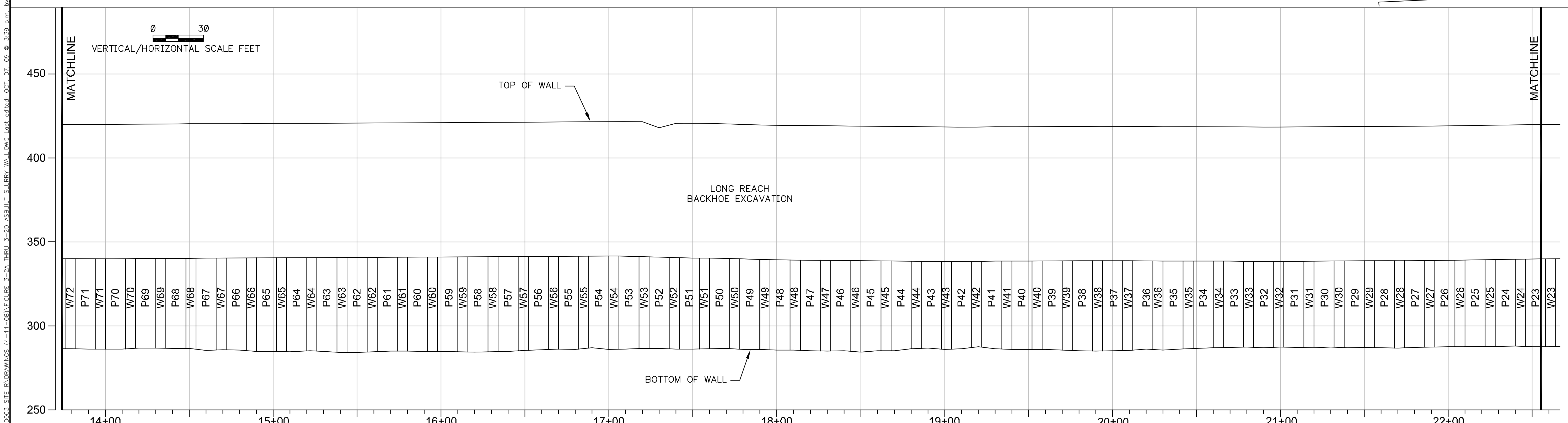
GROUNDWATER MIGRATION CONTROL SYSTEM
FINAL REMEDIAL ACTION COMPLETION REPORT
As Built Panel Constructions

PROJECT NO. 21562001
FIGURE NO. 3-2A





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GROUNDWATER MIGRATION CONTROL SYSTEM

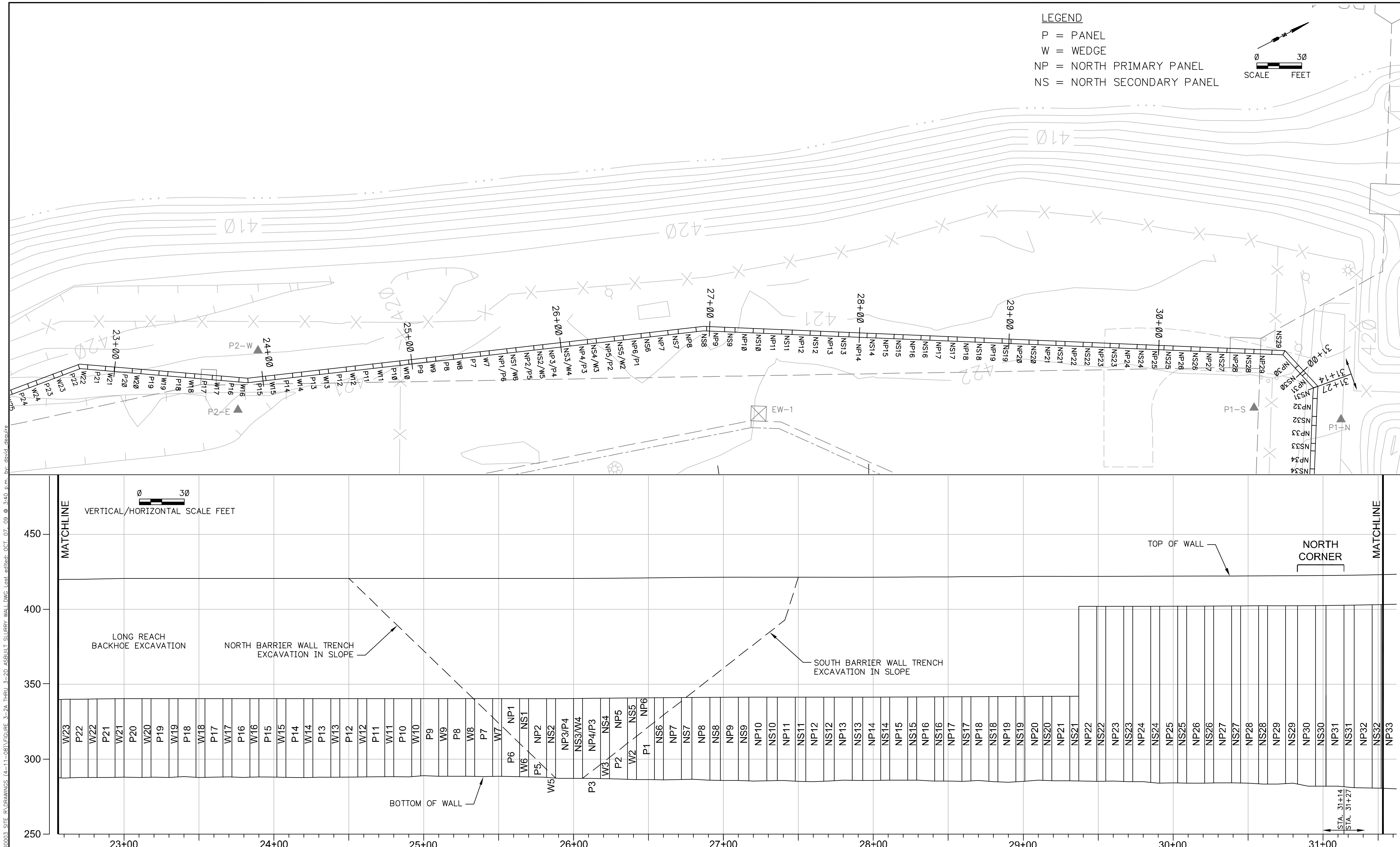
FINAL REMEDIAL ACTION COMPLETION REPORT

As Built Panel Constructions

PROJECT NO. 21562001

FIGURE NO. 3-2B

File: P:\ENVIRONMENTAL\21562001.00003 SITE R\DRAWINGS (4-11-08)\FIGURE 3-2A THRU 3-2D ASBUILT SLURRY WALL.DWG Last edited: OCT. 07, 09 @ 3:39 p.m. by: david_deguire



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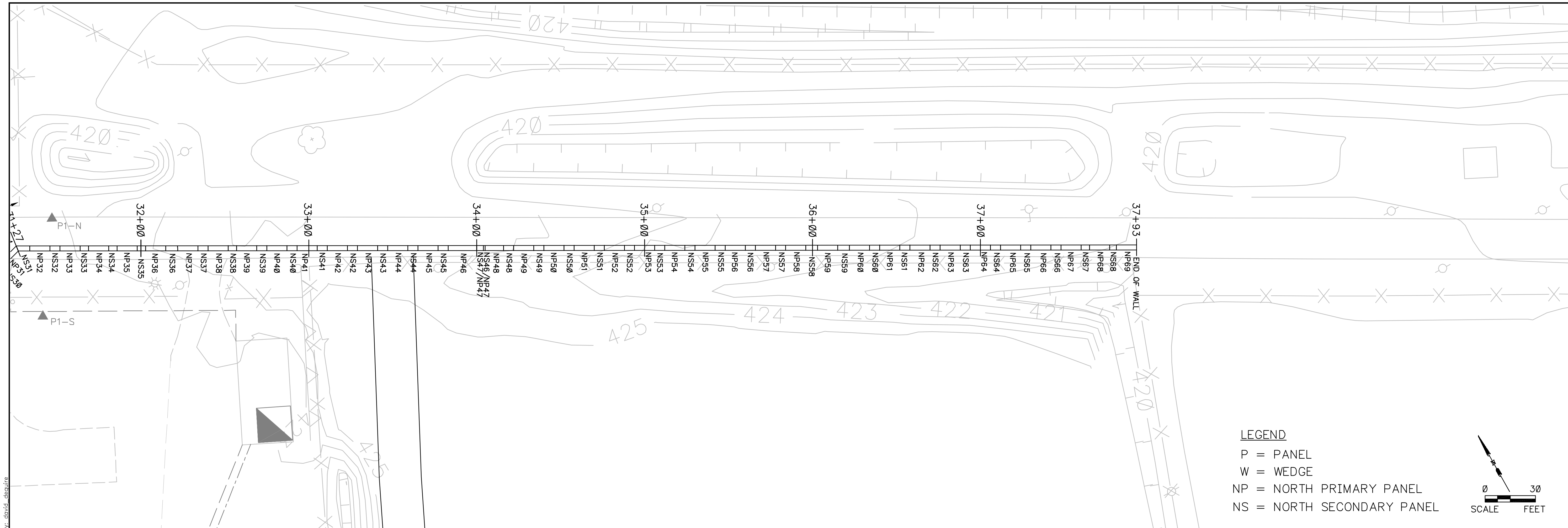
GROUNDWATER MIGRATION CONTROL SYSTEM

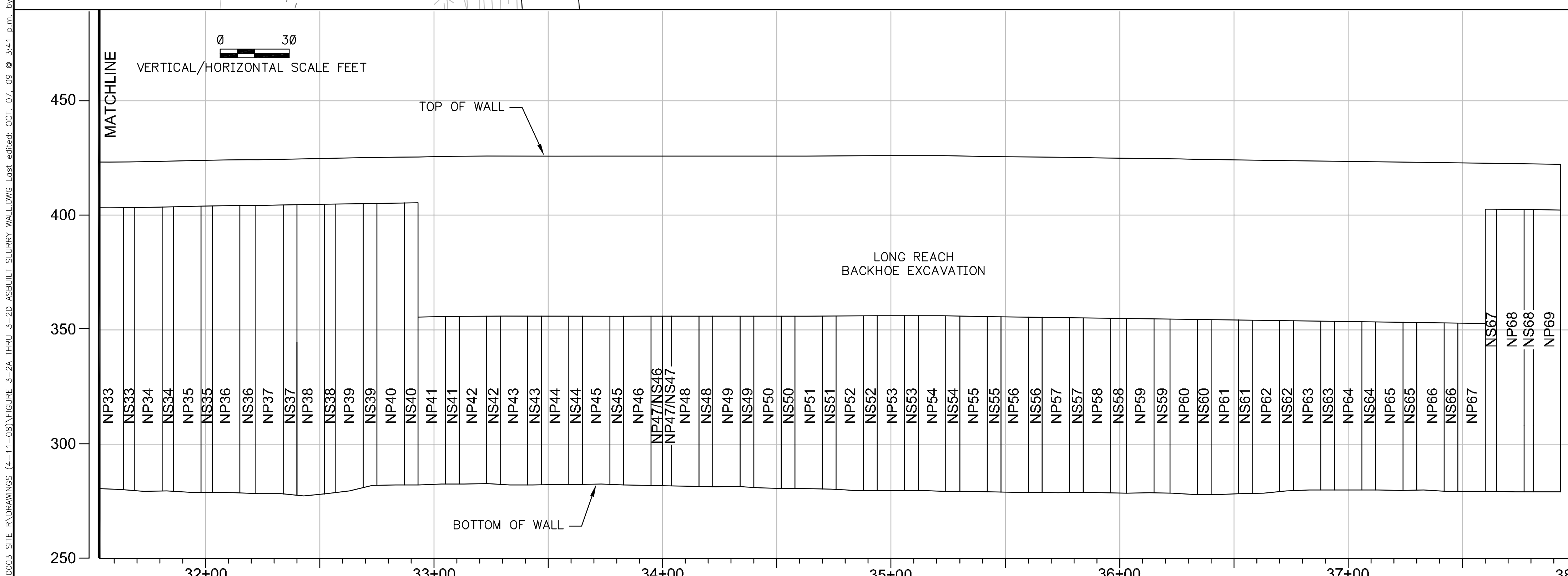
FINAL REMEDIAL ACTION COMPLETION REPORT

As Built Panel Constructions

PROJECT NO. 21562001

FIGURE NO. **3-2C**





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GROUNDWATER MIGRATION CONTROL SYSTEM

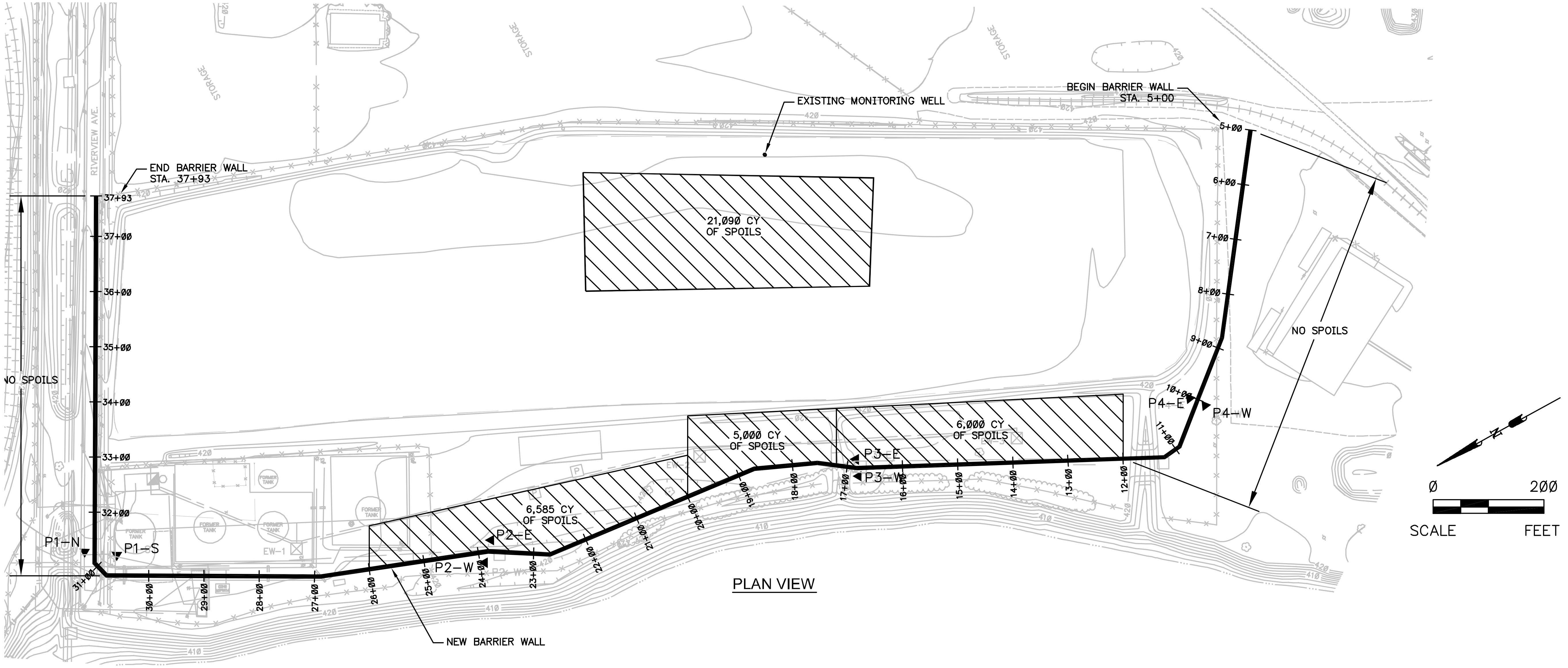
FINAL REMEDIAL ACTION COMPLETION REPORT

As Built Panel Constructions

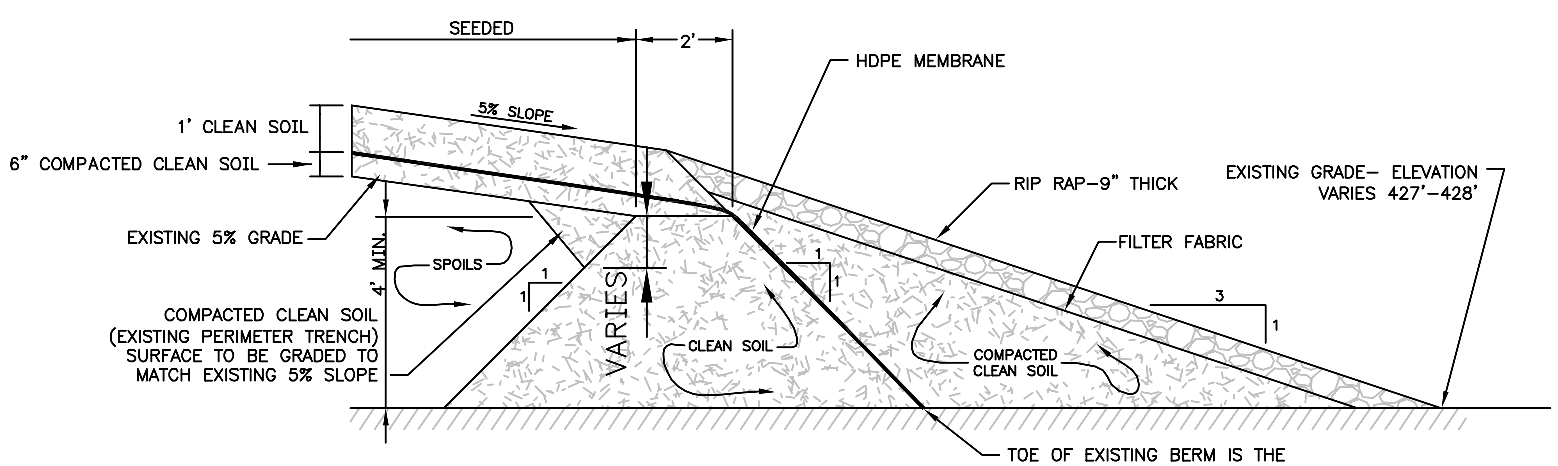
PROJECT NO. 21562001

FIGURE NO. 3-2D

File: P:\ENVIRONMENTAL\21562001.00003 SITE R\DRAWINGS (4-11-08)\FIGURE 3-2A THRU 3-2D ASBUILT SLURRY WALL.DWG Last edited: OCT. 07, 09 @ 3:41 p.m. by: david_deguire



PLAN VIEW



CROSS SECTION
TYPICAL EXTERIOR BERM
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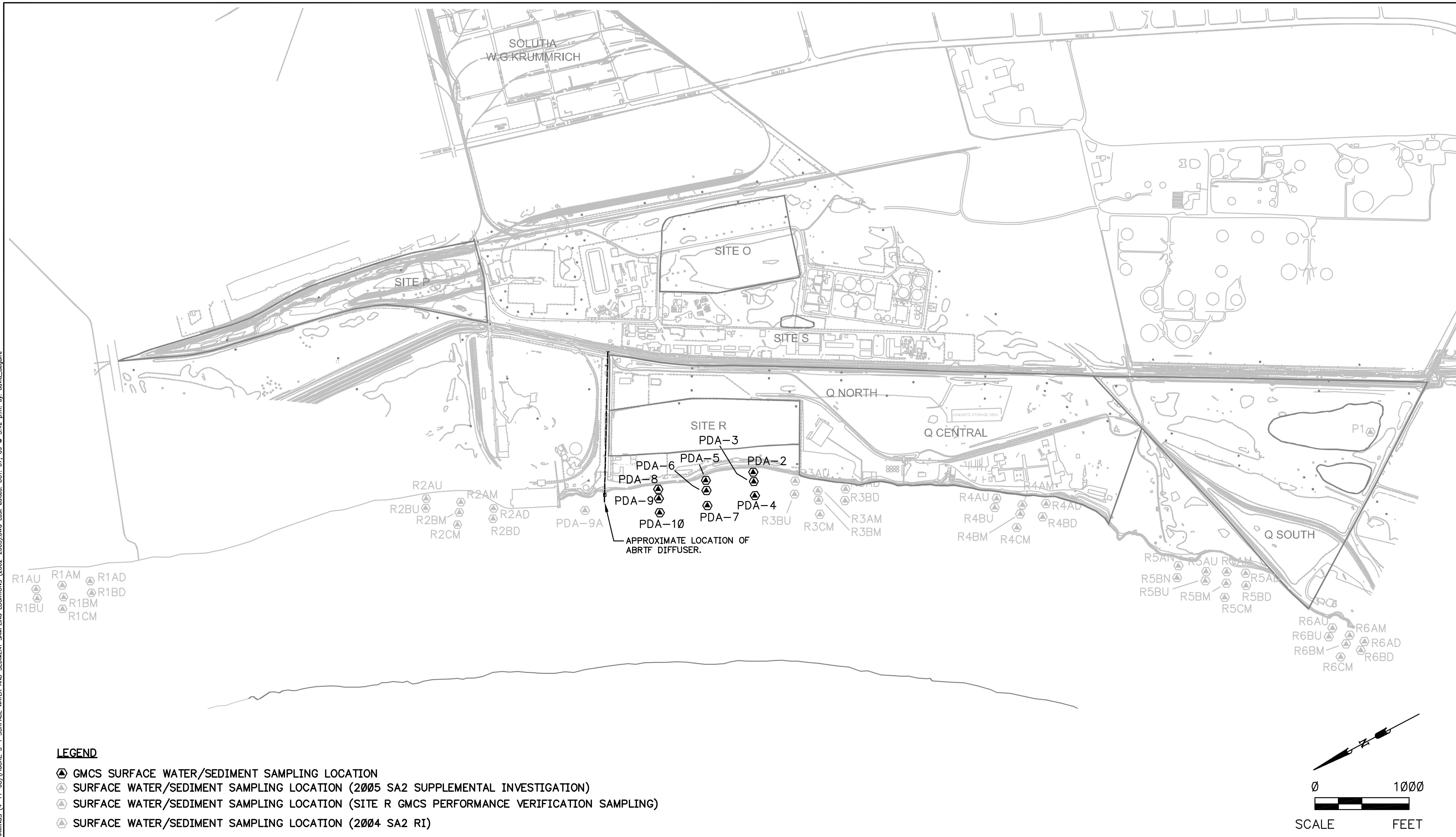
EXCAVATION PLAN FORMER PCB MANUFACTURING AREA W.G. KRUMMRICH FACILITY SAUGET, IL	PROJECT NO. 21562010
URS	
DRN. BY: djd 5/20/08 DSGN. BY: kmb CHKD. BY:	Spoils Stockpile, Plan and Section
FIG. NO.	3-3



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GROUNDWATER MIGRATION CONTROL SYSTEM
FINAL REMEDIAL ACTION COMPLETION REPORT
Surface Water & Sediment Sampling Locations

PROJECT NO. 21562001
FIGURE NO. 5-1

File: P:\ENVIRONMENTAL\21562001.00003 SITE R\DRAWINGS (4-11-08)\FIGURE 5-1 SURFACE WATER AND SEDIMENT SAMPLING LOCATIONS (2002-2005).DWG Last edited: OCT. 07, 09 @ 3:42 p.m. by: david_dequire